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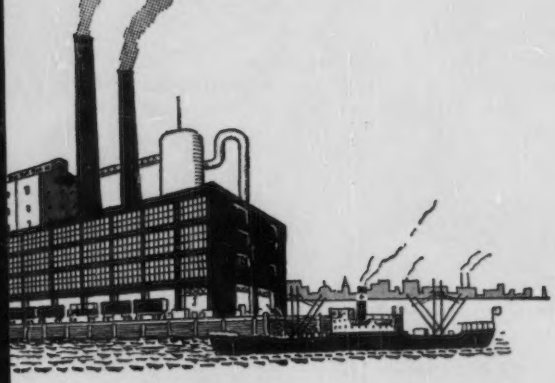

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All articles should be typed on 8½ x 11 inch paper and should be double-spaced. Authors are requested to send with each article a statement as to the field work, special experience, or other background on which the article is based. They are also urged whenever possible to submit maps and graphs in such form that they can be reproduced directly. In cases where it is necessary these will be redrawn at the editorial offices, but this may result in delay in publication. Delay will be avoided, also, if the author will send a caption with each illustration. All map or chart captions should show the source of data or other information unless this is already given in the illustrations. The sources of information for all tables, too, should be shown. Wherever a photograph is used that was not taken by the author, some source credit should appear in the caption.

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A POLICY ON BOOK REVIEWS, 1958

About seven years ago this page carried an editorial, "A Policy on Book Reviews." The policy has not materially changed. Nevertheless, it needs to be restated from time to time, especially for the benefit of our younger readers and of publishers who may wish to submit books for review.

As pointed out on that earlier occasion one of the cornerstones of our policy is to restrict books to be reviewed to certain fields. Ordinarily, our reviews are limited to books in economic geography and in urban geography, but these limits are broadly interpreted and books in sociology, economics, and other neighboring fields are included when they are considered to contribute substantially to the two aspects of geography mentioned.

At least as important as deciding what books are to be reviewed is the question of who shall do the reviewing. With rare exceptions all of our reviews are prepared by geographers. Even where a non-geographer is available who knows the material covered by the book better than any geographer, still it is felt that a geographer is more likely to look at the subject from the standpoint that is wanted by our readers. Subject to this limitation the attempt is made in every instance to get the best qualified reviewer possible. In fact, we ordinarily will not have a book reviewed at all unless we can find a reviewer whose background of specialization and experience seem to qualify him particularly to review it. From all of this you can infer that we request most of our reviews.

Occasionally, a "volunteer" review is received but such reviews are increasingly rare. When it deals with a book that is within our prescribed fields and for which no review has as yet been requested we are glad to consider it. But the editor has to be assured, just as with our regular assigned reviews, that the reviewer has special qualifications for reviewing the book.

Several other matters may be mentioned. Our reviews average 800 to 1000 words in length. No payment is made, but the copy of the book becomes the property of the reviewer. The tone of the review—whether complimentary or adversely critical or somewhere in between—is up to the author of the review. And we do not undertake to check the statements made in a review just as we do not attempt to check the facts in articles in the magazine.

Ordinarily, new editions even in our major fields of interest are not reviewed, but, periodically, new editions received will be listed at the end of the book review section.

Finally, sometimes, in spite of the best of intentions on the part of a prospective reviewer, the review never materializes. But this is rare. Actually, the members of the profession have been remarkably cooperative in this matter of reviews.

R. E. M.

ECONOMIC GEOGRAPHY

VOL. 34 JANUARY, 1958 NO. 1

FREIGHT RATES: SELECTED ASPECTS OF UNIFORM AND NODAL REGIONS*

John W. Alexander, S. Earl Brown, and Richard E. Dahlberg

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IN a commercial economy having specialized transportation, the movement of goods is influenced by several forces, one of which is the freight rate structure. The spatial differences in transport charges is not only a geographic factor influencing the circulation of goods but also a geographic element in terms of which the character of a region may be expressed. "Mankind is not spread evenly over the face of the earth but tends to cluster in certain areas, which vary from each other. . . . Within such areas relationships arise. . . . It is through the means of transportation and communication that these interrelationships are set up and maintained. . . . But the cost of its use is often as great an element in the importance of a transportation line as its actual presence. Hence freight rates are of greatest value in outlining regions and in affecting their organization. This is seen in the practice of zoning rates and of offering special inducements for the movement of certain commodities. . . . If transportation facilities serve to consolidate regions, it must also be observed that freight rates are to regions and to cities what tariffs are to nations. They form a part of the cost of connections with other regions and may be manipulated to the advantage or disadvantage of a given region in almost exactly the same way."[1]

Thus, as a geographic element lending character to regions and as a geographic factor influencing the location of economic activities freight rates have significance for the regional analyst.

OVER-SIMPLIFIED GEOGRAPHIC CONCEPTS OF FREIGHT RATES

Unfortunately, some geographic concepts of freight rates have been oversimplified. As a result, there are spatial differences in such costs which either are not known or are not generally

*This study is based in part upon a research grant from the Graduate School of the University of Wisconsin for the 1952–1953 academic year. Mr. Brown and Mr. Dahlberg carried the entire burden of copying and mapping all the statistics pertaining to Wisconsin's freight rate structures presented herein. They also participated in drafting the manuscript.

[1] Harry E. Moore: *What is Regionalism?* Southern Policy Papers, No. 10, University of North Carolina Press, Chapel Hill, 1937, pp. 2–4.

recognized in many geographic studies. This prevents the regional analyst from clearly understanding the relationships between regional economies and the flow of goods both within a region and between regions.[2] In general, there seem to be two misconceptions: (1) From any given point, freight rates (assessed by the same form of transport) increase similarly in all directions; i.e., the rail rate on a carload of coal from Milwaukee to a point 100 miles northwest is the same as the rail rate on a similar carload of coal from Milwaukee to a point 100 miles southwest. (2) The second misconception is that freight rates always increase with distance. The extreme expression of this fallacy is that rates increase *directly* with distance; i.e., it costs twice as much to ship a commodity 1000 miles as 500 miles. Less erroneous is the idea that rates increase with distance but always at a diminishing rate.[3]

It is difficult to document these two criticisms. In most geographical treatises dealing with economic activity, scarcely any but the most cursory mention is made of transport costs. Without so stating (and therefore not quotable) such studies apparently assume the two concepts expressed above. In any case, the very absence of recognition of freight rate analysis in geographic studies supports the conclusion that geographers are rather uninformed on spatial variations in such costs. On the other hand, a few studies do recognize the role of transport costs but, for want of evidence, assume that freight rate structures are concentric around transport centers. For example, Harris employed this expedient in his analysis of the American market[4] but frankly raised the question "How nearly does the actual freight-rate structure approximate the generalized transport bands used in the calculations of this paper?"[5]

Geographers have made comparatively few investigations of spatial variations in freight rates probably because of rate complexity. "Rate structures are so complex that to generalize them into significant geographic patterns is extraordinarily difficult. . . . In spite of all these difficulties, it would be worth while to attempt some geographic generalization of rate patterns. . . . Rate structures can be studied from a geographic point of view."[6] Nevertheless, in view of the fact that freight rates are fundamentally important in the geography of flow (which in turn is the dynamic aspect of transport geography), because they are spatial variables contributing to regionalism, and because of misconceptions easily drawn regarding freight rates, this article will consider freight rates from two regional viewpoints: uniform regions and nodal regions.

Uniform Freight Rate Regions

A uniform region, as defined by Whittlesey, is homogeneous because all parts of its area contain the feature or features by which it is defined, in this case,

[2] "As an example, under the system of freight rates prevailing before 1925, it cost less to ship fruit from California to New York than from the Ozark fruit region to the same city, while the cost of shipping fruit from California to New York was less than twice that of moving it from Florida and California . . . ." Harry F. Moore, *op. cit.*, p. 3.

[3] For more detailed discussion of these misconceptions, see E. F. Penrose: "The Place of Transport in Economic and Political Geography," United Nations' *Transport and Communications Review*, Volume V, Number 2, April-June, 1952, p. 4.

[4] Chauncy D. Harris: "Market As a Factor in Localization of Industry," *Annals Assn. Amer. Geogrs.*, Vol. 44, 1954, p. 323.

[5] *Ibid.*, p. 348.

[6] Edward L. Ullman and Harold B. Mayer: "Transportation Geography" in *American Geography, Inventory and Prospect*, Preston E. James and Clarence F. Jones, edits., Syracuse, 1954, reference on pp. 326–327.

FIG. 1. United States Freight Rate Territories, 1937. (Source: United States Government, 75th Congress, 1st Session, House Document No. 264, *The Interterritorial Freight Rate Problem of the United States, 1937.*)

similar freight rates.[7] An example of uniform freight rate regions is the structure of railroad class freight rates which prevailed for years in the United States. Since 1887 the rates charged by the nation's railroads have been regulated by the federal government's Interstate Commerce Commission (I.C.C.). It has not been a case of the Commission prescribing rates but rather of either approving or disapproving rates which the railroads proposed. For years the Commission recognized different regions within which the railroads had decided to charge characteristic prices. The five major regions, as mapped by a congressional committee in 1937, appeared in an official House Document and is reproduced as Figure 1 in this article. Table I shows the *average* rate prevailing in each of the five regions. In such a rate structure, a shipment of any given commodity moving X miles in Official Territory was priced, on the average, at a lower freight rate than a shipment of the identical commodity moving the same distance in any other

[7] Derwent Whittlesey: "The Regional Concept and the Regional Method," Chapter II in *American Geography, Inventory and Prospect*, references on pp. 36 and 39.

TABLE I

LEVELS OF FIRST-CLASS FREIGHT RATES

Index numbers indicate the *average* levels of applicable class rates mile for mile in other territories in relation to Official Territory for shipments of up to 1000 miles.

Territory	*Index of rate*
Official or Eastern	100
Southern	139
Western Trunk Line	147
Southwestern	175
Mountain-Pacific	171

Source: United States 75th Congress, 1st Session, House Document No. 264 *The Interterritorial Freight Rate Problem of the United States*, 1937.

rate region, so long as *class rates*[8] applied in both cases. It must be emphasized that the figures presented in Table I and portrayed graphically in Figure 1 are *averages* for all such movements within the region.

The reasons for this regional variation in class rates are exceedingly complex and comprise a sizable body of literature in transportation economics.[9] In general they reflect (a) the principle that efficiencies in mass movement warrant lower rates where heavy traffic occurs, and (b) the influence of competitive forms of cheaper transportation such as waterways along the Atlantic, the Pacific, and the Gulf coasts. In any case, division of the United States in terms of this geographic element produced clearly defined regions of the uniform type.

As a geographic factor, this regionalism in the nation's freight rate structure had a profound impact upon the nation's economic geography. It gave the Northeast a definite rate advantage making it less expensive, on the average, to ship goods in that region than in any other part of the nation. In recent years the I.C.C. received increasing protest from other portions of the country, especially the South, whose leaders complained that the rate structure was regionally discriminatory in favor of the economy of the Official (or Eastern) region. Beginning in the 1940's the I.C.C. reviewed these regional discrepancies in the class rate structure[10] and, in a series of decisions spaced several years apart, gradually erased most of the regional differentiations. By 1952 uniformity had been achieved from the Atlantic Coast to the Rocky Mountains. Nevertheless, the effect of the regional differences in class rates which prevailed from 1887–1952 will be observable in the regionalization of the American economy for many years to come.

NODAL FREIGHT RATE REGIONS

"Nodal regions are homogeneous with respect to internal structures or organization. This structure includes a focus, or foci, and a surrounding area tied to the focus by lines of circulation. . . . Hence the nodal region is bounded by the disappearance or differential weakening of the tie to its own focus in favor of some other focus. Its boundary lines tend to run at right angles to the lines that tie it together."[11] Nodal freight rate regions are delimited in terms of rate structures to/from transport foci. The remainder of the present article is essentially a study of nodal regions[12] discernible in a case study area: the State of Wisconsin.

The specific objectives of the research reported in the following pages are (a) to

[8] Where the movement of a commodity is particularly heavy between any two points, the railroad may publish a reduced rate termed a *commodity* rate. By law, railroads are required to file each new rate with the Commission 30 days before its effective date. Unless protested at least 12 days before the effective date, it becomes an official rate. If protested, the new rate is suspended by the Commission pending investigation at the end of which time it may be disallowed or approved.

[9] For example, Roland B. Eutsler: *Transportation in North Carolina, A Study of Rate Structure and Rate Adjustment*, University of Pennsylvania, 1929; William H. Joubert: *Southern Freight Rates in Transition*, University of Florida Press, 1949; D. Philip Locklin, *Economics of Transportation*, 1947; D. A. MacGibbon, *Railway Rates and the Canadian Railway Commission*, 1917.

[10] F. L. Barton: "The Interstate Commerce Commission Considers The Class Rate Structure," *Journ. of Land and Publ. Utility Econs.*, Vol. 17, 1941, pp. 10–16.

[11] Derwent Whittlesey, *op. cit.*, p. 37.

[12] Examples of other studies in which freight rate regional nodality is implicit, although not always identified as such are: John W. Alexander: "Freight Rates As a Geographic Factor in Illinois," *Econ. Geogr.*, Vol. 20, 1944, pp. 25–30; Stuart P. Daggett and John Carter: *The Structure of Transcontinental Railroad Rates*, University of California Press, Berkeley, 1947; Olaf Lindberg: "An Economic-Geographical Study of the Localization of the Swedish Paper Industry," *Geografiska Annaler*, Arg. XXXV, 1953, Hafte I, pp. 28–40.

present facts with some analysis of freight rate structures in a case study area and (b) to consider problems of methodology in the study of freight rates from the geographical viewpoint.

This is a progress report in a study of Wisconsin's freight rate geography which is still in the descriptive stage. As yet little has been done in interpreting these rate structures or correlating them with other phenomena. The report is issued at this stage with the thought that it will be of interest to specialists concerned with the spatial variations of transport costs.

All maps are of Wisconsin's rate structures during the period 1952–1953.

The State of Wisconsin was selected for study because: (a) At least some types of spatial differences in transport costs prevailing over the earth were assumed to be discernible in an area the size of Wisconsin; (b) transport costs frequently are assessed on a "state" basis; a political state is a meaningful area in the consideration of transport charges;[13] (c) data on transport charges applicable to this political unit are on file in a central place (the Wisconsin Public Service Commission) which is easily accessible in Madison.

Procedure

Maps were constructed of several different freight rate structures: (a) *class* rates on *rail* shipments to/from all points in Wisconsin from/to Chicago, Milwaukee, Green Bay, Superior and Duluth (the first being the major out-of-state shipping center on the southeast and the last being a major out-of-state shipping point on the northwest); (b) *class* rates on *truck* shipments to/from all points in Wisconsin from/to the same five shipping centers listed above; (c) commodity railroad rates on *coal* to all Wisconsin points from the southern Illinois-Indiana coal field, from Milwaukee, from Green Bay, and from Superior.

Data Sources

Data were procured from the State Public Service Commission which has on file in the Capitol all rate tariffs which apply to the movement of freight in Wisconsin.[14]

Mapping Techniques

Rates were plotted on base maps (provided by the Public Service Commission) which show the location of all railroads and shipping points in the State. Plotting of truck rates required interpolating from the State's official highway map for location of points not on railways.

Isarithms, herein termed *isophors*,[15] were constructed as lines connecting the innermost points of equal freight rates. "Innermost" has significance because in the structure of any nodal rate region it is possible for consecutive places on a radiating transport artery to have the same rate to the transport center around which the rate structure is oriented. In such a case the isophor is drawn through the place nearest the transport center

[13] Rates on an *intrastate* flow of goods to a major terminal, or rate-breaking point, are often different than rates on an identical flow of goods destined via that same terminal for another state.

[14] The authors gratefully acknowledge the cooperation of the personnel in the Wisconsin Public Service Commission office, especially Mr. Ivan A. Sherman, Transportation Rate Analyst, and Mr. Harold Hueblein. "Tariffs" are tables of freight charges or transport prices published by the carriers.

[15] The term isophor is derived from the Greek "isos" (equal) and "phora" (charge for carrying freight). Scandinavian scholars have used different terms. Tord Palander employs the term "isotim" defined as a line connecting points of equal delivered price. See E. H. Hoover's discussion of terminology on page 8 of his *Location Theory and the Shoe and Leather Industries*, Harvard University Press, Cambridge, Massachusetts, 1937. Olaf Lindberg uses the term "isovecture" defined as a line joining points of equal transport costs, *op. cit.*, p. 28.

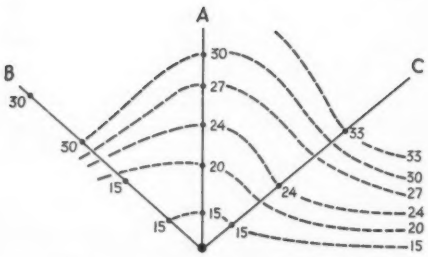


FIG. 2.

which serves as the focus of the nodal region.

Several problems arise in the drawing of such isarithms. How should they be drawn where a sequence of shipping points along one radiating transport artery has a sequence of rates ascending in several small increments while a neighboring radiating line has rates ascending in a few large increments (Fig. 2)? Can the isophors be continuous lines located as per the quoted rates on line A and interpolated on lines B and C? This requires isophors to cross a transport line (thus indicating rates of a given value) where no such rates exist. Figure 3, a portion of a Wisconsin rate structure, illustrates this problem. The rail first class rate per 100 pounds to Chicago is 143 cents from Klevenville and 126 cents from Riley. Rates from all other shipping points (for which rates are published) are plotted on Figure 3. Isophors are drawn for only those rates which are quoted for places which are located in the area mapped. Between Klevenville and Riley there is no shipping point; no quoted rate exists. Yet three isophors (133, 136, and 140) run between the two. Is this realistic? Should isarithms be drawn in locations where there are nonexistent values?

A seçond problem is a visual one. Closely spaced isarithms give the impression of steeper gradients than do isarithms farther apart. Figure 4 illustrates this problem by showing the first class rate structure on rail shipments between Chicago and all Wisconsin points. It has been constructed according to the "interpolated isophor" technique: viz., drawing isophors for rates which are quoted for specific stations, and extending them across all rail lines (even where no such rates are quoted) in order to give form to the rate structure. Thus, there are isophors for values 129, 133, and 136 but none for 130, 131, 132, 134, or 135 because there are no stations in Wisconsin for which such rates are quoted. The visual impression is one of a steep gradient extending through Wonewoc and Kiel because isophors are close together. Actually the rate contrast through this belt is only 10–11 cents.

One solution to these mapping problems could be the construction of isophors at selected constant intervals. However, this might hide important

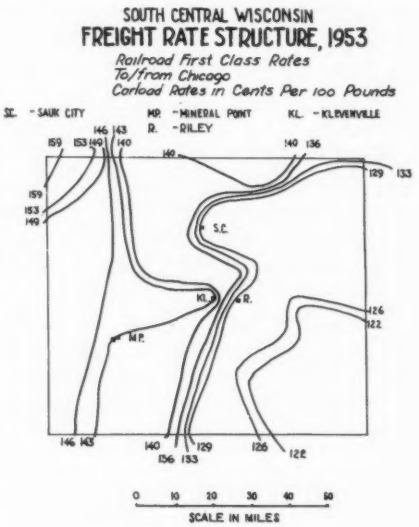
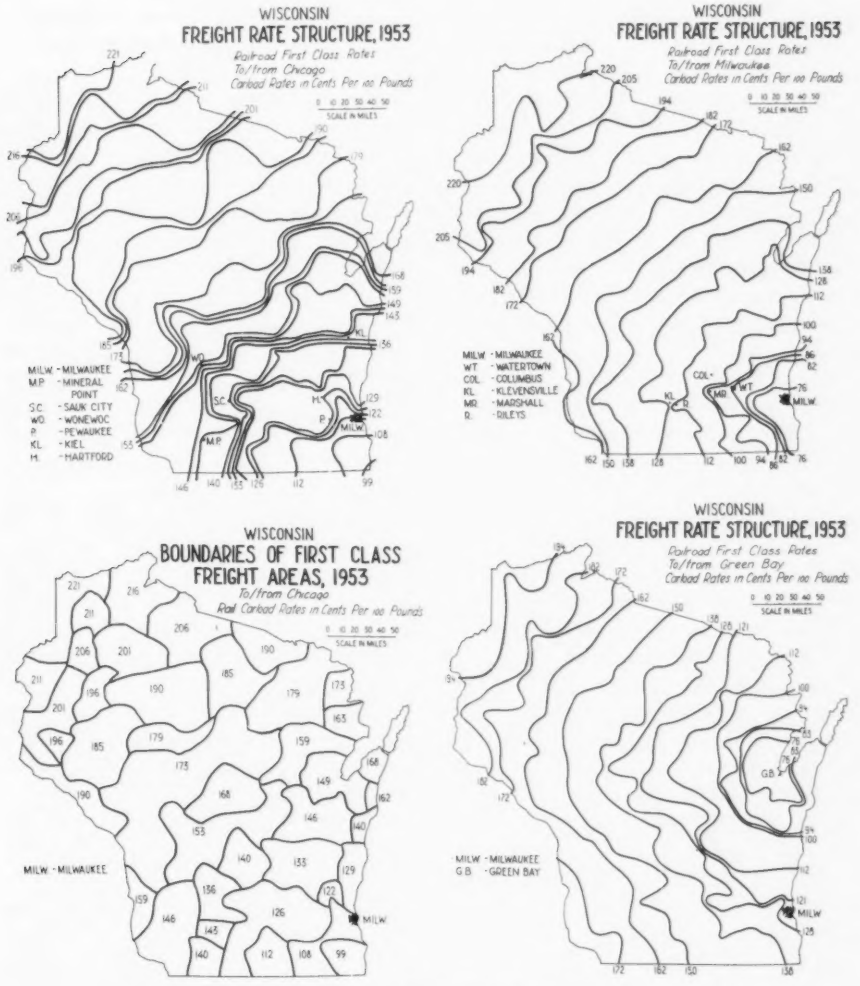


FIG. 3.



FIGS. 4 (upper left), 5 (lower left), 6 (upper right), and 7 (lower right).

deviations from the general structure. For example, application of 10-unit intervals selected at 126, 136, and 146 on Figure 4 would fail to reveal rather abrupt structure changes in the vicinity of Mineral Point. Another difficulty with this technique is that rates may not be quoted for values fitting into a regular interval; for example, there is no 156 rate and no 116 rate anywhere in Wisconsin to continue the sequence proposed in the foregoing illustration.

An alternative mapping technique abandons the use of isarithms in favor of rate area boundaries. Each line would encompass all contiguous places with the same rate. Figure 5 has been constructed on this basis for rail first class rates to/from Chicago. Cartographically this is more accurate than

the isarithmic technique, i.e., no rate is represented in any place if it does not exist there. On the other hand, the selection of adequate symbols is a problem since there are 26 different categories (from the area having a 99 cent rate in the extreme southeast to the area having a 221 cent rate in the extreme northwest). Also, this does not give a clear visual impression of the relationship between rates and distance nor does it give an easily grasped view of a rate structure.

In any case, there is need for improving the technique of mapping freight rate structures.

Railroad First Class Freight Rate Structures

Figures 4, 6, 9, 10, and 11 employ the interpolated isophor technique, showing Wisconsin's structure of rail first class freight rates to/from five major transport centers as of 1952–1953.

Figure 4 shows the rate structure between all Wisconsin rail stations and *Chicago*. Only very broadly is the pattern one of concentric circles, which should prevail if rates increased uniformly in all directions from Chicago. The capricious path of isophors is illustrated by numerous examples. For instance, the rate between Milwaukee and Chicago is 108 cents per 100 pounds. Just north of Milwaukee (on the rail routes along the lake shore) the rate increases abruptly to 129. Between these two values rates of 112, 122, and 126 are quoted elsewhere in Wisconsin. Though closely spaced just north of Milwaukee, these isophors diverge to the west; the 126 and 129 isophors are parallel to a point beyond Hartford where the 129 isophor bends sharply *northwest* while the 126 isophor bends sharply *southeast*. Similar variation involves other pairs of isophors: e.g., 146 and 149, 153 and 159, 185 and 190. Obviously, in this particular structure, rates increase differentially in different directions from the focal city.

The complexity of a freight rate structure is illustrated by the profusion of isarithms on Figure 4 on which every existing rate quoted for any place in the State is represented. For the sake of simplicity, most maps to follow are not, in this respect, complete replicas of Wisconsin's rate structure. Only selected isophors will appear, in order to present more clearly the essence of the structure. The total visual impression of subsequent maps therefore cannot be compared directly with that of Figure 4; however, the complexities of isophor patterns are comparable.

Figure 6 shows the structure of rail first class rates between all Wisconsin shipping points and *Milwaukee*. There is some tendency toward a concentric pattern, yet sharp irregularities in many isophors indicate that increase with distance apparently is not consistent in all directions. Profiles of freight rate gradients to the north, west, southwest, and south of Milwaukee show marked variations (Fig. 8).

It might be supposed that places on a direct route to the focal city of the structure would have lower rates than neighboring places not on such routes. This is not true. For instance, Figure 9 shows Fort Atkinson to have a lower rate to Milwaukee than does Eagle, which is not only on a direct route but also closer to Milwaukee. Figure 9 also reveals sharp structure contrasts between two places on separate direct routes. For example, Columbus and Marshall are on direct routes to Milwaukee, in fact their routes converge at Watertown. Yet the Marshall rate to Milwaukee is 86 cents while that of Columbus is 100 cents. Note the steep gradient between Riley and Klevenville on Figure 8 as well as Figure 3.

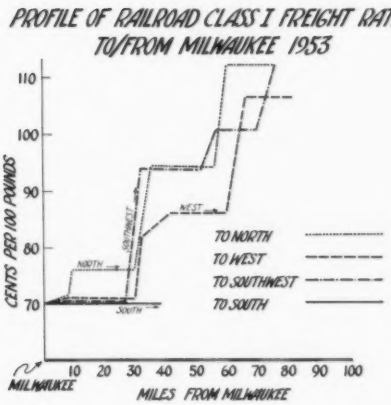


FIG. 8.

The structure of rail first class rates around *Green Bay* (Fig. 7), *Superior* (Fig. 10), and *Duluth* (Fig. 11) reveals the same general arrangement: a tendency toward concentricity but strange deflections in and congestions of isophors. There is an anomaly in the Superior structure north of Milwaukee where nine stations on two different railroads have a 186 rate, in sharp contrast to the 214 rate prevailing around them. This actually represents an error in the published tariffs.[16] In the Duluth rate structure the 159 and 196 isophors are particularly distorted.

Inspection of the foregoing rail rate structures around five focal points reveals the structures of isophors to be very asymmetrical. Rates do not increase consistently with distance in any one direction, or similarly in different directions.

To understand what appears to be capriciousness on the part of rail first class rates one needs to consider three principles which apply in the philosophy of rate making adhered to by the railroads in this nation: (a) the "grouping" principle, (b) the "short line distance" principle, and (c) the "rate step" principle.

The *grouping principle* enables railroads to simplify the publication of class rates. Theoretically, if all rates were assessed on the mileage basis, a separate rate would have to be published between every pair of shipping points in the nation. As a result, each freight agent in the country would have to refer to volumes of tremendous size to determine rates on shipments to/from his depot. By treating several proximal stations as one, the railroads greatly simplify their rate tariffs. In essence, the grouping principle declares that all the stations in a group take the same rate to any other group of stations. The group's specific rate is computed in terms of the group's "control point" which often is the largest settlement in the group's area. Figure 12 shows the location of the 67 areas of station groups which the railroads proposed

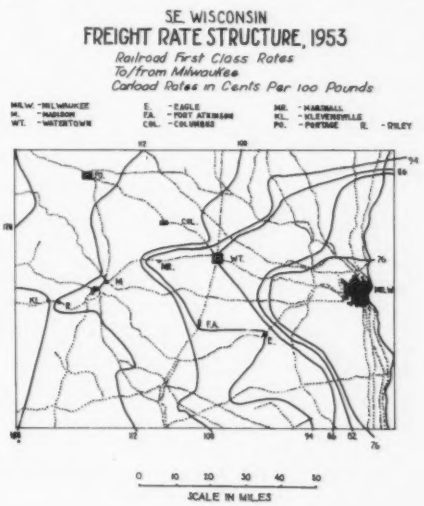
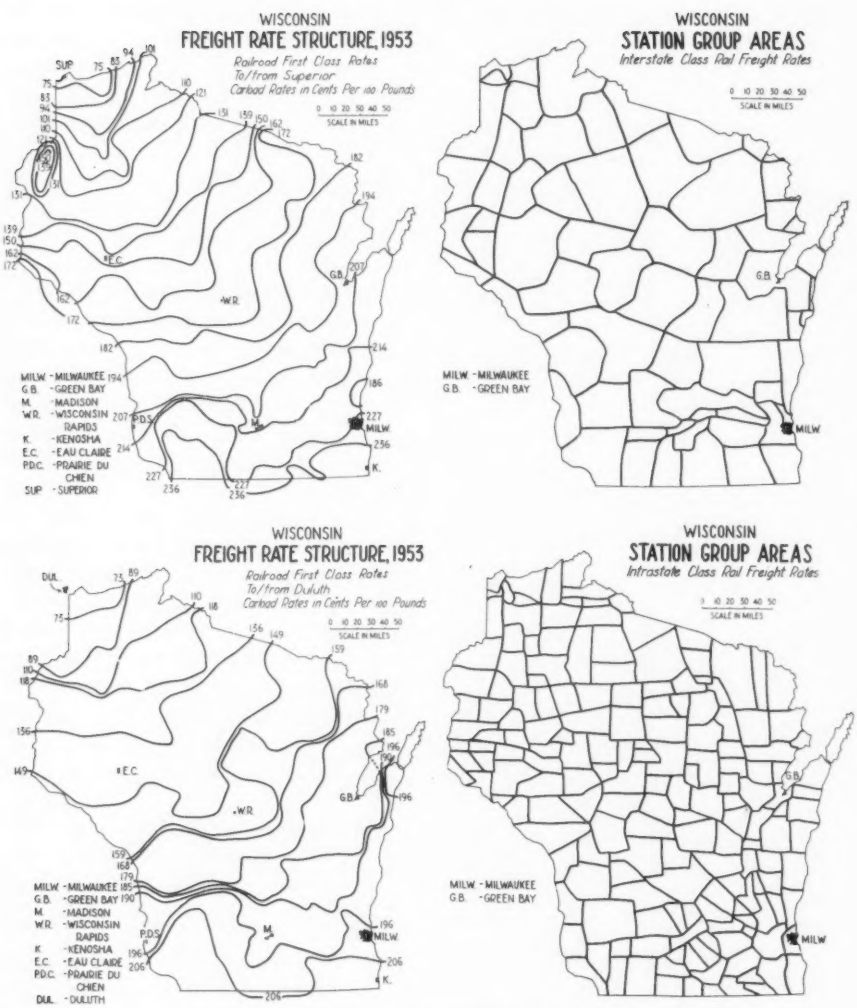


FIG. 9.

[16] Since determining the exact rates to Superior for all Wisconsin points required several computations, it was first thought that an error had been made in computations; however, Mr. Ivan A. Sherman checked the computations, found them to be correct, and verified the conclusion that the tariffs quoted rates for this small area out of harmony with the general rate structure.



FIGS. 10 (upper left), 11 (lower left), 12 (upper right), and 13 (lower right).

(and the Interstate Commerce Commission approved) for the *interstate* class freight rate structure. The major dimension of each group's area is approximately 40 miles although some are longer and a few are shorter. Figure 13 shows that for *intrastate* rail shipments, Wisconsin's class freight rate structure comprises many more (180 to be exact) group areas.[17] Group areas are smaller on Figure 13 than on Figure 12 because intrastate shipments tend to be shorter than interstate.

The "*short line principle*" prescribes that rates shall be computed on the basis of the mileage of the shortest route over which carload freight can be

[17] Figures 12 and 13 are copied from manuscript maps prepared in the Tariff Section of the Wisconsin Public Service Commission, courtesy of Mr. Ivan A. Sherman.

transported without transfer of lading. In application this means that a shipment needing to move from one railroad to another would have to move through interchange points which the railroads have established, analagous to "transfer stations" on a city's rapid transit system. For this reason alone, rate structures could not be expected to be concentric around a transport center unless numerous railroad routes extended outward from it radially.

The third principle followed by the railroads is the *quoting of rates "in steps."* For instance, no *interstate* rates are quoted on shipments of less than 40 miles, but from 40 to 100 miles the rate increases in steps of five miles and is computed in terms of the distance between the control points of groups. For distances between 100 and 240 miles the steps are 10 miles in length; they are 20 miles long for distances over 240 miles. *Intrastate* rates in Wisconsin are quoted in terms of five mile steps on shipments of 100 miles or less and of 10 mile steps on shipments exceeding 100 miles.

Such methods of computing rates by railroads have evolved gradually over the years and have been permitted by the government commissions.

The group-area philosophy portrayed by the patterns of Figures 12 and 13, the "short line" principle, and the philosophy of increasing rates in steps are fundamental to the understanding of the isophor maps of class rates presented in this study, and are excellent examples of a cultural geographic factor (philosophy of rate-making) operating to influence the locational pattern of a geographic element, the freight rate structure of Wisconsin.

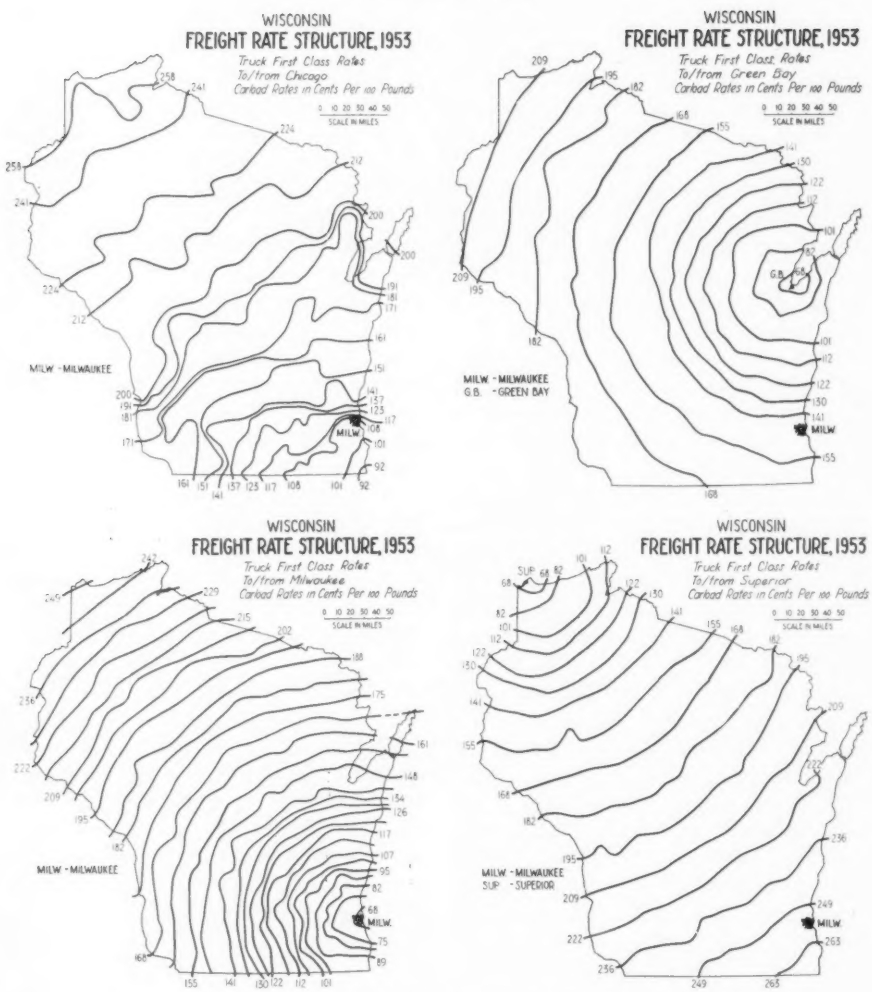
Truck First Class Freight Rate Structures

Maps of Wisconsin structures of common carrier truck rates are shown in Figures 14–18. Admittedly, more traffic probably moves by *private* truck and by *contract* truck, but it is impossible to construct rate maps for such flow. The structures of rates to/from *Chicago* (Fig. 14) are represented by selected isophors and reveal more irregularities in the nearer rather than the distant portions of the State. By contrast, the structures of rates to/from *Milwaukee*, *Green Bay*, and *Superior* (Figs. 15, 16, and 17) show surprising concentricity. The Milwaukee structure (Fig. 15) is shown in its entirety; i.e., all isophors are drawn. For the sake of simplicity, alternate isophors have been omitted on Figures 16 and 17.

A different philosophy of rate making has prevailed in determining truck rates. The trucking authorities, in contrast to the railroad men, proposed to the commissions that truck rates be computed generally in terms of *airline* distances rather than the "short-line-involving-no-transfer-of-lading" principle. This is the main explanation for Wisconsin's truck rate structures being more symmetrical than the rail rates. Nevertheless, the fact that truck rates, like rail rates, increase in shorter steps for short hauls and, on interstate shipments, also respond to the location of control points means that the interstate truck class rate structures for Chicago and Duluth, Figure 20, tend to be less symmetrical in their inner areas.

Class Rate Nodal Regions

Synthesis of rail rate structures and truck rate structures just presented enables the delimitation of nodal regions around the five focal centers, Figure 18. The nodal region for each focus was constructed by delimiting all shipping points linked by a lower rate to that center than to any other. For example, the first class rail rate per 100 pounds from Madison is 126 to Chicago, 107



FIGS. 14 (upper left), 15 (lower left), 16 (upper right), and 17 (lower right).

to Milwaukee, 138 to Green Bay, 211 to Superior, and 190 to Duluth. Therefore, Madison is in the Milwaukee nodal region of rail rates. Where truck rates are lower than rail rates a solid black symbol is employed.

Two broad observations can be drawn from the map of nodal regions. First, over most of Wisconsin, first class rail rates are lower than first class truck rates.[18] However, in the immediate hinterlands of each focus the truck rates are lower. Chicago and Duluth have no such "truck advantage regions" in Wisconsin, and Superior's is small. The Milwaukee nodal area in which truck

[18] The reader is reminded that the areas delimited on Figure 18 as having lower truck rates are delimited in terms of common carrier rates, it being impossible to procure data on private truck movements and contract truck movements.

rates are less than rail rates exceeds Green Bay's which, in turn, exceeds Superior's. At least in the structures mapped herein, it appears that the larger the transport center, the more extensive the area in which truck transport has a favorable rate differential over railroads. Whether this principle is true or not for other transport centers in the State and in the nation is yet to be investigated.

The extent of the truck nodal regions within the rail nodal regions noted above relates to the well-known fact that on short hauls the truck is more efficient than the train. Recognition of this division of talent is demonstrated in the "piggy-back" development in which trucks accumulate loads in the hinterlands of major rail centers, assemble at the center, are loaded bodily onto rail flat cars and carried by rail over a long haul to another rail center where the truck disembarks, finishing its movement in short hauls to distributing points in the center's hinterland.

The second observation is that nodal rate regions can have peculiar shapes and locations, the most unusual situations resulting where a nodal region involving intrastate shipments is enmeshed with one involving interstate traffic. That any part of Wisconsin should have lower rates to Chicago than to Milwaukee may seem surprising, yet Chicago's nodal region penetrates the extreme southwestern corner of the State which is served by the Chicago, Burlington and Quincy Railroad's main line between Chicago and the Twin Cities. Milwaukee's nodal region blankets most of southern Wisconsin and actually reaches the Mississippi River at two places: (a) in the vicinity of Prairie du Chien where rates via the Milwaukee Railroad's direct line to Milwaukee are lower than the Burlington's rates to Chicago, thus fragmenting

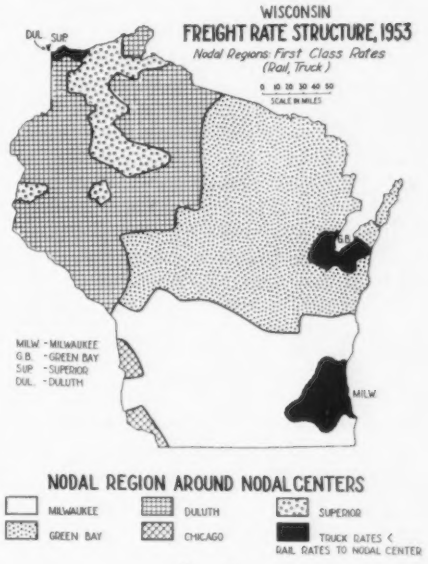


FIG. 18.

the Chicago nodal region, and (b) in the vicinity of LaCrosse where another direct line to Milwaukee has effected lower rates than to the other four centers.

Even more unusual is the relative location of the Duluth and Superior nodal regions. Duluth's extends much farther south. In spite of the fact that Duluth itself is west of Superior, its nodal region also extends farther east than Superior's. Superior's nodal region actually is an aggregate of several fragmented areas within the Duluth nodal region. Incongruous as it may seem, Figure 18 reveals that shippers and consignees in most of northwestern Wisconsin have lower first class rates on shipments to/from Duluth, Minnesota than to/from Superior, Wisconsin. Comparison of Figures 10 and 11 reveals that, even outside the Duluth nodal region, rates from Wisconsin to Duluth are generally lower than to Superior. For example, comparative rates for selected points are presented

TABLE II

RAILROAD FIRST CLASS RATES

(per 100 pounds)

From	*To Duluth, Minnesota*	*To Superior, Wisconsin*
Eau Claire	$1.36	$1.39
Wisconsin Rapids	1.53	1.62
Green Bay	1.79	1.99
Prairie du Chien	1.90	2.07
Madison	1.90	2.11
Milwaukee	1.96	2.27
Kenosha	2.06	2.36

in Table II. A graphic view of this information is presented in Figure 19, a comparative profile of the Duluth and Superior rate structures along the rail routes connecting Superior with Eau Claire, Portage, Milwaukee, and Kenosha. In the northern half of this route the two profiles intersect eight times, indicating that there are four segments where lower rates to Superior prevail alternating with four segments of lower rates to Duluth. The route's southern half sees the Superior structure climbing high above Duluth's. The differential reaches 30 cents in the vicinity of Oconomowoc, shrinks to 26 cents in the Milwaukee area, and expands again to 30 cents between Racine and Kenosha. Similar intertwinings of profiles would result if the Duluth and Superior structures were compared along other routes. At first glance, such a relationship of structures would appear illogical unless one remembers that the dotted graph portrays an interstate structure of rates, whereas the solid line represents intrastate structure which both result from rate computation methods which differ in terms of (a) size of group areas of stations and (b) length of steps by which rates increase.

Commodity Rate Structures: Coal

Figures 21, 22, and 23[19] show Wisconsin's freight rate structures as of 1952–1953 on movement of a selected commodity, coal, chosen because it moves between more points in larger tonnage than any other commodity.

Figure 21 portrays the structure on coal rates from the southern Illinois bituminous coal field from which most Wisconsin localities receive coal. The original map showed a confusion of isophors in the southern part of the State; for simplicity of reproduction 10 isophors have been deleted between the 344 and 437 rates. North of the 437 isophor only three have been deleted. The map reveals clearly the rate advantage enjoyed by southeastern Wisconsin. Most places have rates of 388 or 420 cents per ton. Northward the

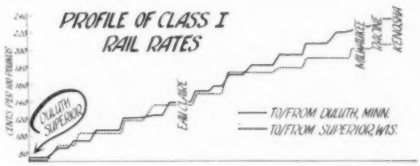
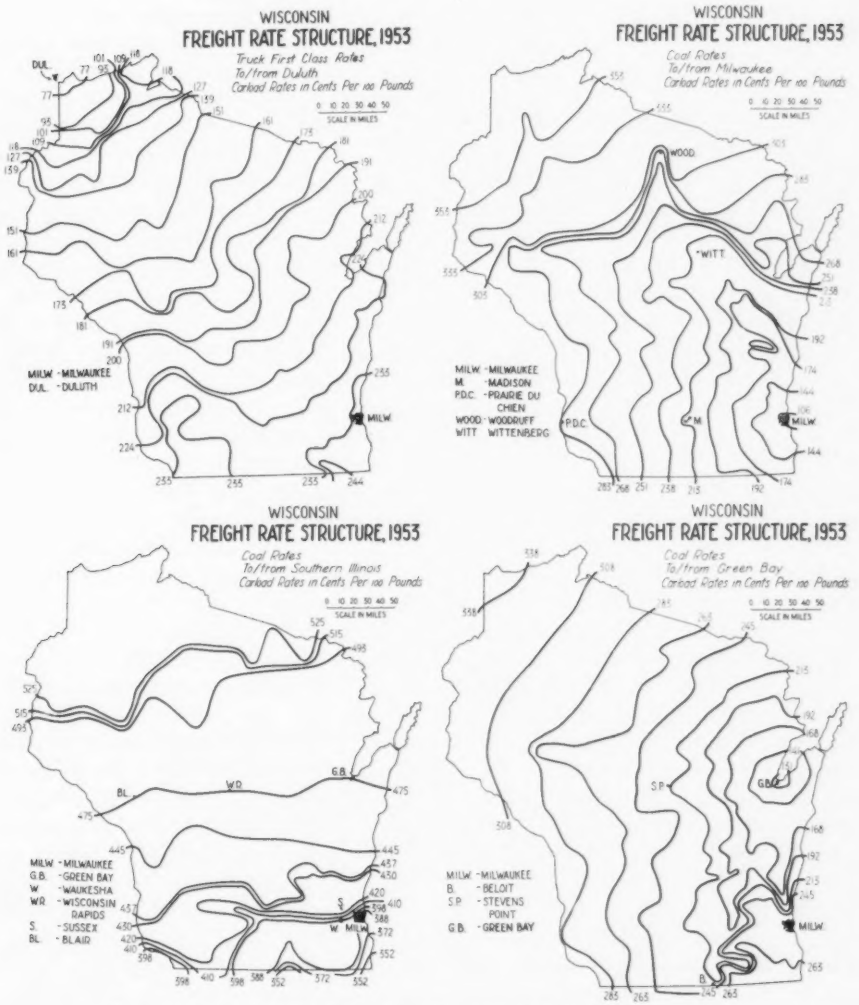


FIG. 19.

rates increase at rather long intervals, but the increases are abrupt. Figure 21 illustrates one of the mapping problems discussed earlier. A steep gradient is implied by the congestion of three isophors between Waukesha and Sussex, separated by a 25 cent differential (between 395 and 420). By contrast, a gentle gradient appears to prevail across the central portion of the state through Blair, Wisconsin Rapids, and Green Bay, where there is no close spacing of isophors. Yet here the rate increases sharply in a single step from 445 to 475, a differential of 30 cents per ton.

The lowest rates on Figure 21 occur, not along the Lake Michigan shore, but 60 miles westward along the Rock River Valley. Beloit's rate of 341 is the lowest

[19] These maps are based on coal rates filed with the Public Service Commission and recorded also by Mr. W. F. Ehmann for the Wisconsin Coal Bureau, Inc., who provided the data for this portion of the study.



FIGS. 20 (upper left), 21 (lower left), 22 (upper right), and 23 (lower right).

in the State, 47 cents lower than Milwaukee's, 12 cents lower than Racine's. This concession was granted the Beloit area by the I.C.C. in response to vigorous persuasion by manufactural interests in the Rock River Valley, and is of significance in perpetuating this small industrial belt as one of the nation's more intensely developed industrial nodes.[20]

The complexity of the structure on rates from *Milwaukee* almost defies description (Figure 22). The original map was so intricate as to be illegible in reduced form. The map reproduced here omits two-thirds of the isophors in

[20] For further analysis of this adjustment on coal rates see John W. Alexander: *Geography of Manufacturing in the Rock River Valley*, University of Wisconsin School of Commerce, Bureau of Business Research Service, 1949, pp. 163–164.

an effort to portray the major structural characteristics which reveal an asymmetrical arrangement of rates very low to the northwest. For instance, the rate from Milwaukee to Madison, a distance of 90 miles, is 208 cents per ton; but in a northerly direction the 208 rate carries 200 miles to Wittenberg. Two hundred miles west of Milwaukee the rate is 278 at Prairie du Chien. A 278 rate in a northwesterly direction carries as far as Woodruff, almost to the Michigan border. It is difficult to explain all such idiosyncracies in the freight rate structure. However, certain factors can be identified. For example, the northward looping of isophors in the eastern portion of Wisconsin (e.g., the 213 isophor) is due to the competitive position of other coal gateways such as Green Bay. The railroads, with the approval of the Commission, have given Milwaukee a favorable competitive rate in Green Bay's hinterland. The result is that some communities in eastern Wisconsin enjoy lower rates on dock coal from Milwaukee than do communities closer to Milwaukee but located in southwestern Wisconsin. The strange pattern of isophors in north-central Wisconsin, like a prong pointing northward, is the result of what rate analysts term "hold-downs" to give manufacturing firms in the Wisconsin River Valley competitive rates as compared to industry in the Fox River Valley to the east.[21] The same principle has been observed already in the case of the Rock River Valley on Figure 21.

Another unusual aspect of a rate structure portrayed by Figure 22 is the "negative anomaly" 50 miles north of Milwaukee. This is one result of the "equalization clause" which, in the words of Ivan A. Sherman of Wisconsin's Public Service Commission, "permits railroads to equalize without undue discrimination the rates to destinations from more distant ports, or to reduce the spread in rates from more distant ports over those from nearer ports; but such equalization or reduction in rates shall be to a level not lower than the rate that would be produced by the scale at 50 per cent of the rate-making distance from the more distant port." This equalization clause has been in effect for decades, ever since Appalachian coal began moving through Wisconsin's ports. This clause states another philosophy of rate making which, as a spatial variable, is both a cultural geographic factor and a geographic element.

The coal rate structures portrayed in Figures 21–23 are unique in the United States, according to the Wisconsin Public Service Commission. In no other state is there the overlapping of so many rate structures on coal movements.

To the absolute rate values on Figure 22 should be added $3.45, the rate on coal from the Appalachian field via rail and water to Milwaukee. Appalachian coal moving via the Great Lakes to Milwaukee, Green Bay, Superior, and other Wisconsin ports is termed "dock coal." The rate on "dock coal" to Madison would be $3.45 plus $2.08 equalling $5.53 which has a differential of $1.58 above Madison's $3.95 rate from southern Illinois. This is a major reason why inland consumers who do not require the higher quality Appalachian coal prefer the Illinois product.

Wisconsin's major nodal regions in terms of "*dock* coal" commodity rates are shown in Figure 24 which is based not only on Figures 22 and 23 but also on individual rate structures constructed around all other important coal ports (Racine, Port Washington, Sheboygan,

[21] Mr. Ivan A. Sherman in personal interview.

Manitowoc, Marinette, Ashland, and Superior). In every case the transport charge from Appalachian coal fields to lake port was added to the charge from lake port to Wisconsin points. Nodal regions then were delimited in terms of over-all rates from coal fields to destination.

The large blank area on Figure 24 indicates that the pattern of dock coal rate nodal regions is more complex than the construction of class rate nodal regions. Figure 18 reveals no areas of overlap; every place in the State can be ascribed to a single nodal region. This is impossible for dock coal rates. Nodal regions involving no overlap are outlined in Figure 24 and, in the aggregate, comprise less than half of Wisconsin. In most of southern Wisconsin a station is likely to enjoy equally low rates on dock coal from at least two, and often more, of the coal receiving ports. This appears to result from at least two causes: (a) Transport charges from the Appalachian coal producing fields are quoted for groups of Wisconsin ports rather than on a distance basis. Table III illustrates this point with data on shipments from Pittsburgh. (b) The equalization clause (mentioned earlier) enables railroads to quote equal rates between a point and two or more ports.

However, when rates on Illinois coal are considered, all of Wisconsin is in the Illinois nodal region excepting the extreme north (i.e., northernmost portions of the nodal regions ascribed to Green Bay, to Marinette, to Ashland, and to Superior) and the seven communities having ports receiving dock coal (Racine, Milwaukee, Port Washington, Sheboygan, Manitowoc, Green Bay, and Marinette).

TABLE III

TRANSPORT CHARGES PER TON ON COAL FROM PITTSBURGH TO WISCONSIN DOCKS

Superior	$3.31
Ashland	3.31
Marinette	3.38
Green Bay	3.38
Manitowoc	3.38
Sheboygan	3.38
Port Washington	3.38
Milwaukee	3.45
Racine	3.45

Source: Mr. W. F. Ehman, Wisconsin Coal Bureau, Inc.

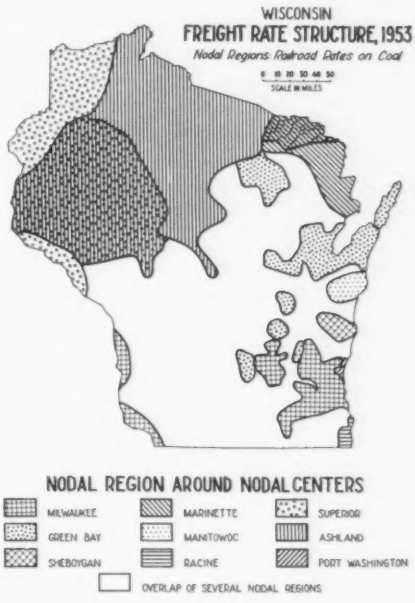


FIG. 24.

Summary Comments

1. Maps of selected components of Wisconsin's freight rate structure, on both *interstate* and *intrastate* shipments, reveal that rates vary markedly with distance. Isophors are not spaced at regular intervals.

2. The maps reveal that rates vary greatly with *direction*. Isophors twist and bend; they do not follow circular paths.

3. The explanation for these patterns or locational arrangements of rates is found, in part at least, in the philosophy of rate making which the railroads follow. Five important aspects of this

philosophy have been shown to be: (a) the grouping principle, (b) the short line principle, (c) the rate-step principle, (d) the equalization principle, and (e) the hold-down principle. All five policies help effect spatial differences in transport charges.

4. Freight rate structures can be used to define nodal regions which may be useful in analyzing functional regions of the more important transport centers. Such nodal freight rate regions may be based on class rates or on commodity rates.

5. Many problems posed in mapping isophors remain unsolved. Should an isophor be constructed in only that part of the state where its value is quoted as a rate, thereby "dangling" in other parts of the state or terminating against other isophors? Or should an isophor once plotted in the area of its rate's occurrence be constructed continuously across the state maintaining its position relative to the other isophors? Should isophors be constructed for every value of rate quoted, or should only selected intervals be represented? The latter alternative often leads to the predicament where a consistent interval cannot be maintained, where no rates exist for some values which would appear in a consistent scale of intervals.

6. Logical steps in further research on freight rate structures include (a) an investigation of causes (other than the five cited in No. 3 above) behind the strange structural patterns and deviations of the isophors from concentricity, (b) a study of the actual movement of goods to determine the degree of conformance with the nodal regions as defined in terms of freight rate structures, (c) research into the influence of freight rate structures on the location of economic activities, and vice versa, (d) additional commodity studies to appraise their similarity with the class rate structures and the coal rate structures, and (e) experiments with techniques for mapping freight rate structures.

RECENT TRENDS AND DEVELOPMENTS IN THE BRITISH COAL MINING INDUSTRY

Trevor M. Thomas

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THE coal industry is by far the major source of primary fuel in Britain. To administer this industry, a public corporation, the National Coal Board, responsible through Parliament to the people, was set up on January 1, 1947. The Board thus became the greatest single employer of labor in the country, directing a labor force of nearly 800,000 workers. Opencast mining, originally the responsibility of the Ministry of Fuel and Power, was taken over by the National Coal Board on April 1, 1952.

Each of nine Divisional Coal Boards, appointed by the National Board, controls one of the main coal fields or groups of coal fields in the country (Fig. 1). The Scottish Division comprises the concentration of coal fields in south Scotland ranging from Ayrshire in the west to East Fifeshire in the east; the Northern Division covers the Northumberland coal field and the smaller Cumberland field; the Durham Division coincides with the Durham coal field; the North Eastern Division is formed mainly of the Yorkshire section of the large Yorkshire, Derbyshire and Nottinghamshire coal field; the East Midland Division takes in the remainder of this coal field and the small south Derbyshire and Leicestershire coal field; the North Western Division includes the Lancashire and Cheshire and North Wales coal fields; the West Midlands Division combines the relatively restricted exposed coal fields of North Staffordshire, South Staffordshire, Cannock Chase, and Warwickshire, and their more extensive concealed extensions into one unit; the South Western Division, dominated by the important South Wales coal field, also includes the minor Forest of Dean and Bristol and Somerset coal fields; and, finally, the South Eastern Division looks after the wholly concealed Kent coal field. These nine divisions are further split up into 49 areas, each of which comprises a geographical grouping of several collieries.

The National Coal Board shoulders a heavy responsibility; failure to raise the output of coal to a level sufficiently high to meet the increasing need for energy will have drastic repercussions on the country's economic stability and general well-being. Success in this task is governed by the amount of money effectively invested, by the numbers of men and officials employed at all levels, the time they work, and the effort and skill they put into their job with the tools made available to them by an efficient management.[1]

Extent of Reserves and Types of Coal Available

Estimates of workable reserves of coal in Britain have been made at

[1] Investing in Coal, Progress and Prospects under the Plan for Coal, National Coal Board, April, 1956, p. 5.

FIG. 1. Map showing National Coal Board divisions in the United Kingdom.

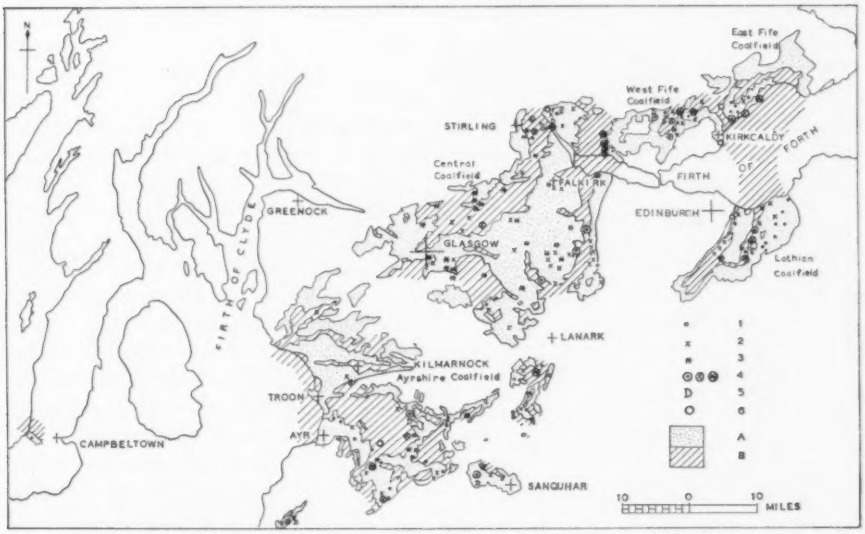

FIG. 2. The Scottish coal fields. Numbers refer as follows: 1, 2, and 3, productive collieries in 1955; 1, collieries with productivity rates above the average for the United Kingdom; 2, collieries with productivity rates up to 25 per cent below the average for the United Kingdom; 3, collieries with productivity rates more than 25 per cent below the average for the United Kingdom; 4, collieries in categories 1 to 3 which have been or are being subject to major capital schemes; 5, productive new drift mines which constitute major capital schemes; 6, new collieries or projected new collieries not yet (1956) in production. Pattern A refers to exposed coal fields and pattern B, concealed coal fields. In each case the boundaries are partly based on those on the 1-625,000 map of the Iron and Steel Industry of the United Kingdom, published by the Ordnance Survey, 1945.

intervals from 1860 onwards. The most recently published of these is that of the Coal Survey (Regional Survey Reports, 1945–46) which defines the resources as being sufficient for more than a hundred years' working. Since 1947 the National Coal Board has been engaged on the task of reassessing the reserves quantitatively in the light of the data now available. Exploration has been greatly intensified and from 1947 to 1954 the total depth of bore holes drilled exceeded 970 million feet. With the supplementary information so provided it is now calculated that the total workable reserves are at least 43,000 million tons—more than enough for 200 years working at the present rate of extraction.[2]

In some of the older coal fields large areas of shallow-lying coal are rapidly being worked out. The full extent of the concealed extensions of several coal fields, whether these be undersea or below a capping of Permo-Triassic beds, has yet to be determined. It seems likely that such virgin areas will offer opportunities for important new mining developments although even here economic mining prospects are not likely to be universally favorable. The only regions where, in the light of present knowledge, there are real possibilities for extensive new development in the not-too-distant future are those of Fife, East Yorkshire and Nottinghamshire, North Staffordshire, the concealed areas in the West Midlands, and the anthracite area of the South Wales coal field.

The Scottish coal fields, unlike those of the remainder of Britain other than

[2] Fifty Questions and Answers on British Coal, National Coal Board, 1955, p. 7.

the northeast of England, are fortunate in having coal seams of economic importance within the Limestone Coal Group as well as within the Productive Coal Measures (Fig. 2). The Lothians and Ayrshire coal fields still contain important untapped coals, but in the Central coal field the better reserves have been extracted so that many of the collieries are operating under adverse geological conditions and a large proportion of the dwindling output is being won from thin seams. Large reserves are located in West Fife and Clackmannan, but by far the greatest coal resources in Scotland are now to be found in East Fife and the seaward extension of this coal field across the Firth of Forth. The extent of workable reserves accessible to coastal pits is immense, representing one of the few really rich areas available for extensive exploitation in Britain. This richness is determined by the high proportion of coal both within the Productive Coal Measures and the Limestone Coal Group. Thus between Leven and Kirkcaldy, where all the subdivisions of the Scottish Carboniferous rocks cross the East Fife coast obliquely and dip seawards in an easterly direction, the Productive Coal Measures show 17 workable seams in a vertical thickness of 1470 feet and the Limestone Coal Group nine workable seams in 820 feet.

According to the Regional Survey Committee's estimate,[3] the workable reserves within the Northumberland coal field amounted to 1762 million tons proved, with a further 340 million tons unproved but likely to be substantiated. The main area for future extraction lies to the north of Blyth (Fig. 3).

In the West Durham coal field most of the important seams have been extensively worked, and the remaining reserves are limited and occur mainly in the upper seams (Fig. 4). A high proportion of the output is gained from thin seams. In East Durham there are considerable reserves in the coastal area but future prospects in the undersea area and to a lesser extent beneath the Magnesian Limestone cover of southeast Durham still require detailed verification. Although an easterly deterioration in both quality and thickness is a feature of many seams in the undersea extension of this coal field it is probable that a few seams are still workable up to 6 miles or more from the coast. Eliminating seams less than 18 inches thick the total workable reserves of the Durham coal field were calculated in 1942 as being at least 3000 million tons.[4]

Although administered by two separate divisions of the National Coal Board (North Eastern and East Midlands) the Yorkshire, Nottinghamshire and North Derbyshire coal field is one geological entity (Fig. 5). Coal Measures are exposed on the western side but to the east they are concealed beneath an increasing cover of Permo-Triassic, Jurassic, and eventually Cretaceous rocks. The concealed coal field extends eastward at least as far as the neighborhood of Market Weighton, Gainsborough, Lincoln, and Grantham. No eastern boundary for the Coal Measures has so far been found and the area already proved is now roughly 2000 square miles.[5] Generally

[3] Northumberland and Cumberland Coalfields, Regional Survey Report (Northern A Region), Ministry of Fuel and Power, H.M.S.O., 1945, p. 5.

[4] Durham Coalfield, Regional Survey Report (Northern B Region), Ministry of Fuel and Power, H.M.S.O., 1945, p. 10.

[5] The Concealed Coalfield of Yorkshire and Nottinghamshire, Memoir Geol. Survey (U.K.) H.M.S.O., 1951, p. 1.

the Coal Measures become markedly thinner and poorer in coal towards the east and southeast although in the western part of the concealed coal field the thickness of the famous Top Hard or Barnsley Seam has remained very consistent. An active boring program in the south Nottinghamshire section of the concealed field has proved workable extensions of the virgin seams above and below the Top Hard. The Regional Survey Committee's combined estimates of the workable reserves of the whole coal field,[6] including proved areas and those scheduled for development as well as unproved and possible additional reserves, amounted to 13,391 million tons. This great wealth of resources is derived from extent of area rather than from vertical density of coal. The coals within the older western parts of the field are by no means approaching the exhaustion stage. Further exploration to supplement the knowledge gained from the Coal Board's borings and the extensive drilling for oil in the East Midland oil field is still needed to elucidate seam thickness and quality and the detailed structure of the more remote parts of the concealed field. Notwithstanding this, it is probably true to say that Yorkshire alone contains the largest reserve of workable coal in Great Britain.

The main part of the Lancashire coal field dips rather steeply southward below the thick cover of Triassic rocks of the Cheshire Plain and is much disturbed by major faults so that the working areas are broken into a number of relatively small panels (Fig. 6). To combat these difficult physical conditions several mines are being reorganized with a view to the adoption of horizon mining. Workings here have

[6] North Midland Coalfield, North Eastern Coalfield, Regional Survey Reports, Ministry of Fuel and Power, H.M.S.O., 1945.

FIG. 3. The Northumberland and Durham coal fields. For explanation of the legend see caption for Figure 2.

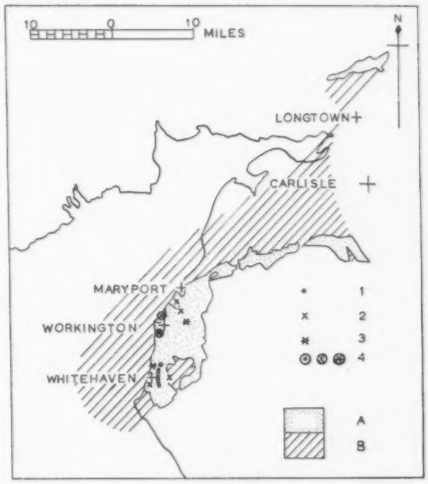

FIG. 4. The Cumberland coal field. For explanation of the legend see caption for Figure 2.

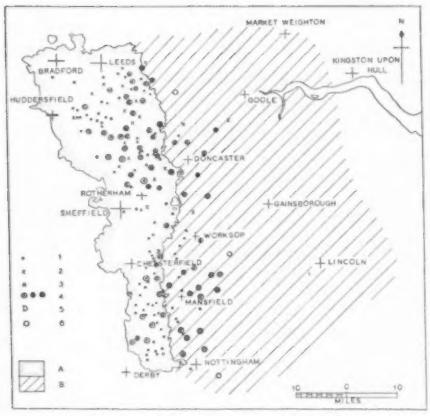

FIG. 5. The Yorkshire, Derbyshire, and Nottinghamshire coal field. For explanation of the legend see caption for Figure 2.

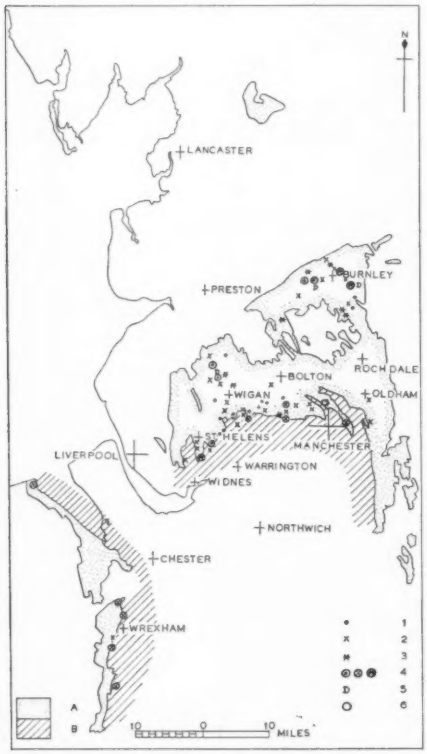

FIG. 6. The North Wales and Lancashire coal fields. For explanation of the legend see caption for Figure 2.

penetrated to the greatest depths in Great Britain (approximately 4100 feet). For seams above 18 inches thick the total reserves in this coal field were placed at 3110 million tons as compared with 1110 million tons for the smaller North Wales coal field,[7] to which it is directly linked by the deeply buried Coal Measures assumed to underlie the Cheshire Plain.

The small Cumberland coal field abutting on the hills of the Lake District is again highly faulted. Proved and anticipated reserves have been estimated at 583 million tons.[8] Much of this coal is scattered and occurs in rather thin seams. The most valuable reserves undoubtedly lie in the undersea extension northwestward below Solway Firth. Recent exploratory boring suggests that the concealed section of the coal field, to the northeast of Maryport, contains workable seams.

In the Midlands the several coal fields of relatively limited surface extent are all, to a varying degree, probably interconnected beneath the enveloping Triassic blanket (Fig. 7). Workable concealed northwesterly extensions have been proved for the Cannock Chase, Warwickshire and South Derbyshire and Leicestershire coal fields; in addition an important northerly continuation of the South Staffordshire coal field has been found with a full section of Productive Coal Measures. Bore holes to the west of the South Staffordshire coal field also indicate reserves at depth.[9] The North Staffordshire coal field shows the highest density of workable coal in the country; proved

[7] North Western Coalfields, Regional Survey Report, Ministry of Fuel and Power, H.M.S.O., 1945, p. 61.

[8] Northumberland and Cumberland Coalfields (see footnote 3 above), p. 34.

[9] Summary of Progress of the Geological Survey of Great Britain and the Museum of Practical Geology for the year 1951, H.M.S.O., p. 27.

reserves were calculated by the Regional Survey Committee at 1686 million tons.[10] Future developments will be concentrated in the central and southern portions of the coal field. Within the South Staffordshire and Cannock Chase coal field the reserves of the proved areas have been much depleted (estimated by the Regional Survey Committee as 1233 million tons) and inferior coals preponderate in what remains. Likewise the small South Derbyshire and Leicestershire and Warwickshire coal fields have good concentrations of coal (estimated proved reserves according to the Regional Survey Committee of 783 million and 878 million tons respectively) but of indifferent quality.

The Regional Survey Committee suggested a figure of 8200 million tons for the workable reserves of the South Wales coal field at depths not exceeding 4000 feet.[11] This coal field has been much entered by sporatic mining operations and although the total quantities of workable coal are very great they do not possess the attraction of unspoiled areas (Fig. 8). The northeastern part of the field, in particular, has been extensively worked. Areas in which large reserves are intact are confined to the South Crop, ranging from Burry Port in the west to Bedwas in the east, the deeper-lying anthracite zone of the North Crop, and the north Glamorgan region around the head of the Rhondda Valley. Hitherto the complex geological structure with steep dips and low-angled thrusting have severely restricted mining activity on the South Crop where systems of horizon mining will be employed in most of the reconstruction schemes.

The small coal basin of the Forest of Dean has been intensively mined and contains no appreciable reserves outside the existing colliery takes. In the Bristol and Somerset coal field a great deal of geological research supplemented by boring will be required before the workable resources can be properly assessed. Mining has been on a small scale and has not penetrated far into the deeper measures. Faulting, especially in the Somerset section, is on a severe scale.

FIG. 7. The Midland coal fields—Shropshire and South Staffordshire, North Staffordshire, South Derbyshire and Leicestershire, Warwickshire. For explanation of the legend see caption for Figure 2.

The concealed Kent coal field is rather deep-lying and is in the form of a flat basin with a low southeasterly tilt (Fig. 9). The estimate made by the Regional Survey Committee for the major portion of the known extent of the coal field indicated a workable reserve of 2201 million tons.[12] The seams are subject to much variation and inconsistency and the coals worked to date are all very friable.

[10] The Coalfields of the Midland Region, Regional Survey Report, Ministry of Fuel and Power, H.M.S.O., 1945, p. 2.

[11] The South Wales Coalfield, Regional Survey Report, Ministry of Fuel and Power, H.M.S.O., 1946, p. 93.

[12] Kent Coalfield, Regional Survey Report, Ministry of Fuel and Power, H.M.S.O., 1945, p. 25.

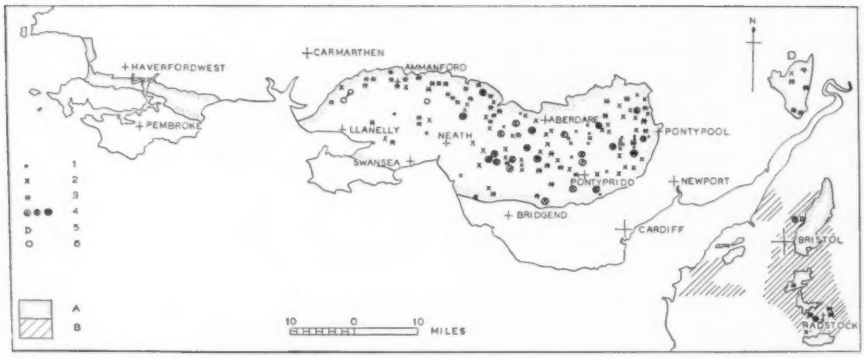

FIG. 8. The South Wales, Bristol and Somerset, and Forest of Dean coal fields. For explanation of the legend see caption for Figure 2.

Great Britain produces a wide variety of coals ranging without a break from the mature or high rank anthracites with 4 to 5 per cent of volatile matter to the immature or low rank coals with 40 to 45 per cent. Over this range there are accompanying changes in caking properties which profoundly influence the uses to which the different coals can be put.[13] Apart from small quantities in Scotland, anthracites are entirely restricted to the northwestern section of the South Wales coal field.

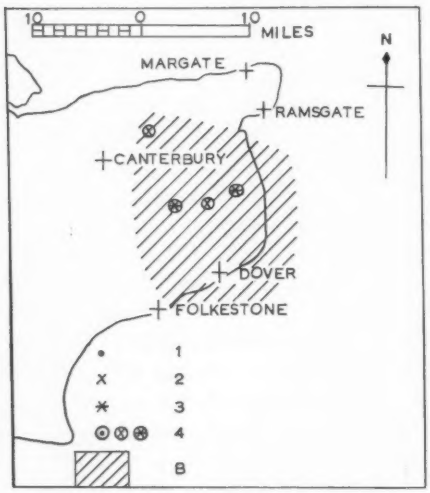

FIG. 9. The Kent coal field. For explanation of the legend see caption for Figure 2.

Dry steam coals are also available solely from South Wales although a limited potential exists for these within the Kent coal field. Substantial reserves of coking steam coal are available in the South Wales coal field and also make up about 35 per cent of Kent's small output. Of supreme importance to the steel industry the medium-volatile, special-coking coals are available in large quantities only from West Durham and South Wales. In the future, North Staffordshire may produce appreciable quantities of this type of coal. The high-volatile, strongly and very strongly caking coals have a wider distribution and are especially significant in East Durham and West Yorkshire. High volatile medium and weakly caking coals are the predominant types of coal in Northumberland and are available in relatively large quantities from Lancashire, Yorkshire, Nottinghamshire, North Derbyshire, North Staffordshire, Cannock Chase, and the Scottish coal fields. The high volatile very weakly caking and non-caking coals account for a significant proportion of the Northumberland, Lancashire, Yorkshire, and North Staffordshire

[13] Plan for Coal, National Coal Board, 1950, p. 47.

coals; over half of those of Nottinghamshire and North Derbyshire; virtually the whole of those of South Derbyshire, Leicestershire and Warwickshire; and a very high proportion of Cannock Chase, South Staffordshire, and Scottish coals.

DEEP MINED COAL—POST-WAR TRENDS OF OUTPUT, MANPOWER AND PRODUCTIVITY

Output of deep mined coal in the United Kingdom increased annually from 1946 to 1952, totalling 181,243,000 tons in the former year and 214,324,000 tons in the latter year (Fig. 10). Since 1952 this upward trend has been checked and the 210,232,000 tons for 1955 represents a decrease of 3,762,000 tons on the 1954 figure. Only one coal field—the major Yorkshire, Derbyshire, and Nottinghamshire field—showed a continuous rise of production throughout this period, from 63,366,571 tons of salable coal in 1947 to 83,735,530 tons in 1955.[14] No great change has been recorded from the Scottish coal fields, the 1955 output being slightly lower than that for 1947. In the important Durham and South Wales coal fields the steady rise in production throughout the first 5 or 6 years of nationalization of the industry has not been maintained so that, in each case, recent years have witnessed a slight diminution of output. The Northumberland, Cumberland, Lancashire, and South Derbyshire and Leicestershire coal fields have all shown a general slow rise in production. No conspicuous changes have occurred either in the West Midland coal fields or in the small North Wales, Kent, and Somerset and Bristol fields. A continual decline in output is evident in the minor Forest of Dean coal basin.

[14] National Coal Board, Report and Accounts, annually for 1947 to 1955.

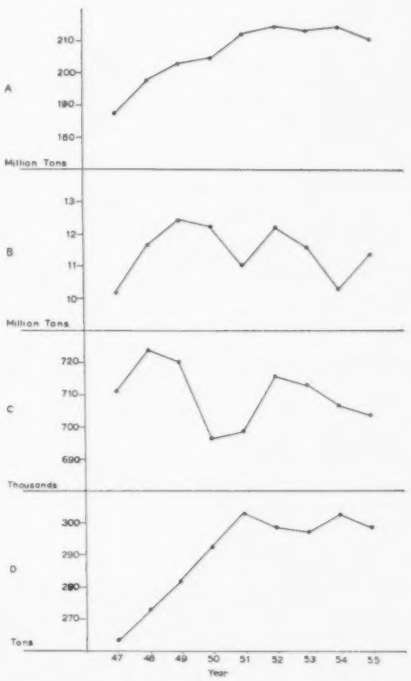

FIG. 10. Graphs indicating recent trends in the British coal mining industry. Letters refer as follows: A, annual output of deep-mined coal; B, annual output of opencast coal; C, man power employed; D, productivity rates in tons per man year for all workers. (From published National Coal Board figures.)

In the postwar period exports of British coal (including cargo exports, overseas bunker depots, and foreign bunkers, but excluding patent fuel) reached a maximum of 19,245,000 tons in 1949. In 1955, on the other hand, 14,018,000 tons were exported, the chief recipient countries being Denmark, the Irish Republic, Sweden, and France, in that order. The South Wales coal field continues to be the main exporting field within the industry, and in 1955 its ports sent out 3,719,000 tons. During the winter of 1951–52, Britain imported 334,000 tons of coal; in 1955 this rate of importation had expanded to an all-time high of 11,618,000

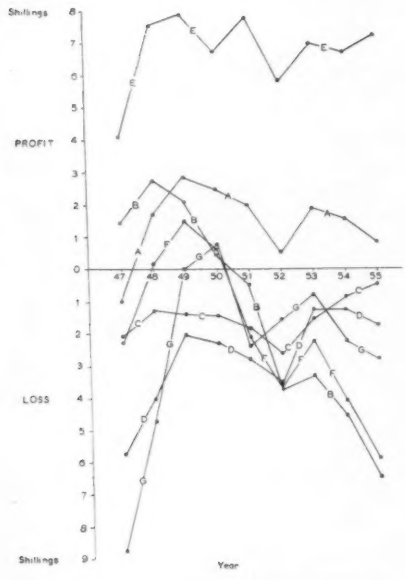

FIG. 11. Comparative graphs illustrating annual variations in colliery profits and losses per ton of salable coal (before charging interest) for the major coal fields of the United Kingdom (based on statistics published in the annual reports and accounts of the National Coal Board). Letters refer as follows: A, all National Coal Board collieries of the United Kingdom; B, Scottish coal fields; C, Northumberland coal field; D, Durham coal field; E, Yorkshire, Derbyshire, and Nottinghamshire coal field; F, Lancashire coal field; G, South Wales coal field.

tons, of which 5,522,000 tons were obtained from the United States.[15]

Between 1923 and 1946 the number of wage earners on colliery books decreased by 463,000. Since 1947 these have averaged just over 700,000, there being no major decrease in employees during this period although from 1953 to 1955 net wastage exceeded recruitment into the industry by 17,000.

Closures and amalgamations carried out by the National Coal Board have reduced the number of mines raising coal from 1564 in 1946 to 1297 in 1955.

[15] National Coal Board, Report and Accounts for 1955, Vol. II, Accounts and Statistical Tables, p. 140.

Of the 888 productive units operated by the National Coal Board in 1954, as many as 359 employed less than 500 wage earners; 275 had mining complements of 500 to 1000; 208 were large collieries with 1000 to 2000 employees; and 46 were major concerns with 2000 to 4000 miners. In the same year 439 small mines were operating under license from the Board, nearly half of these being located in the South Wales and Forest of Dean coal fields.

Productivity within the industry showed a steady increase from 1.074 tons per man shift for all workers (or 263 tons per man year) in 1947 to 1.210 tons in 1951 (303 tons per man year) but by 1955 this had fallen slightly to 299 tons per man year. In 1955, divisional variation in the output per overall man shift ranged from 1.827 tons for the East Midland Division to 0.924 tons in the South Western Division. A number of small new drift mines have achieved a high rate of output in the past few years; discounting these it is generally true to say that under normal conditions productivity increases with the size of the unit. Thus in 1954, categorizing the mines according to mining complement, the highest productivity—328.2 tons per man year—was recorded in those mines employing 1500 to 1999 workers.[16]

In Table I all the National Coal Board productive collieries are tabulated according to output per man year and set against the national average. This clearly reflects the difficult mining conditions in the older coal fields—the Central coal field of Scotland, Northumberland, West Durham, Lancashire, and South Wales. In the latter coal field it is apparent that all the collieries raising anthracite have a productivity

[16] Ministry of Fuel and Power Statistical Digest, 1955, H.M.S.O., Table 10, p. 30.

TABLE I

PRODUCTIVITY IN MINES OPERATED BY THE NATIONAL COAL BOARD, 1955

Division	*Coal field*	*Number of productive collieries*	*Number of collieries with a productivity level above the average for the U.K.*	*Number of collieries with a productivity level 25 per cent above the average for the U.K.*	*Number of collieries with a productivity level below the average for the U.K.*	*Number of collieries with a productivity level 25 per cent below the average for the U.K.*
SCOTTISH		171	51	21	120	39
	West Fife	21	4	1	17	5
	Lothians	23	12	8	11	..
	Central	70	10	4	60	26*
	Ayrshire	48	20	6	28	8
	East Fife	9	5	2	4	1
NORTHERN		68	25	9	43	10
	Northumberland	59	24	9	35	7
	Cumberland	9	1	..	8	3
DURHAM		130	21	8	109	39
	West Durham	95	14	8	81	33
	East Durham	35	7	..	28	6
NORTH EASTERN		111	73	29	38	3
	Yorkshire and North Nottinghamshire	111	73	29	38	3
NORTH WESTERN		68	18	4	50	11
	Lancashire	62	18	4	44	11
	North Wales	6	..	..	6	..
EAST MIDLANDS		89	88	72	1	1
	Nottinghamshire and North Derbyshire	73	72	56	1	1
	Leicestershire and South Derbyshire	16	16	16	..	..
WEST MIDLANDS		52	30	6	22	1
	North Staffordshire	20	12	4	8	..
	Cannock Chase	14	9	2	5	1
	South Staffordshire	7	2	..	5	..
	Warwickshire	11	7	..	4	..
SOUTH WESTERN		155	22	2	133	63
	South Wales	141	21	1	120	55
	Steam and Bituminous	110	21	1	89	29
	Anthracite	31	..	..	31	26
	Forest of Dean	6	..	..	6	4
	Bristol and Somerset	8	1	1	7	4
SOUTH EASTERN	Kent	4	..	..	4	2
Total for U.K.		848	328	151	520	169

*Including Shropshire.

level below the national average. The better facilities for economic extractions in the Yorkshire, Derbyshire and Nottinghamshire, and South Derbyshire and Leicestershire coal fields are also well brought out. Although the table gives a concise picture of the regional state of the British coal industry due regard must also be taken of the qualities of coal produced. Thus although the collieries of the South Wales and Durham coal fields have continuously operated at a loss since 1951 (Fig. 11), as compared with the steady profits gained since 1947 by the North Eastern and East Midland coal fields referred to above, the degree of this loss has been reduced by the high-grade anthracites and coking and dry steam coals extracted in the first field and by the excellent quality coking coals raised in the West Durham area.

OPENCAST COAL MINING

Opencast operations, or strip mining as it is known in the United States, were commenced in 1942 and by the end of 1955 had produced 134,495,600 tons of coal.[17] A maximum annual production of 12,439,800 tons was recorded in the year ending December 28, 1949. More than 60 per cent of each annual output of opencast coal has been obtained from the Northumberland, Durham, and Yorkshire, Derbyshire, and Nottinghamshire coal fields where the prevalent low dips of the component seams considerably aid this form of coal getting. An important contribution has also been made by the South Wales coal field, this being particularly true of the anthracite section of the field which showed a maximum annual output of 905,100 tons of this scarce raw material in 1950.

At the end of 1955 there were 115 productive sites within the United Kingdom; during the same year 47 sites were worked out. Seventy-two of these sites were scheduled to produce less than 300,000 tons each; only 11 were expected to yield more than a million tons apiece. Since 1947 an annual production of more than ten million tons has been maintained from opencast coal sites. The total of 11,365,700 tons for 1955 was 11 per cent higher than the 1954 figure. Without opencast working there would have been little or no coal exported in recent years. At existing prices, if the annual output from opencast sites had to be replaced by imported coal the cost would be about £75,000,000 a year, and the country's balance of payments would suffer in consequence.[18]

The National Coal Board's long-term policy, therefore, is to maintain and, wherever possible, to increase opencast output. Proved resources available for production at the end of 1955 were estimated at 38,509,000 tons of which 15,687,000 tons were located in the Durham and Northumberland coal fields.[19] To achieve this increased production larger and deeper deposits will have to be worked as the more accessible seams become exhausted. Modern excavating plants, including some of the largest draglines obtainable, have been brought into general use on the major sites. Mechanical advances have been so rapid within the past ten years and the civil engineering firms taking on this new enterprise have mastered the technique of opencast extraction so quickly that it is now possible to achieve the remarkable output of 33 tons of coal per man day. The Board's American opencast consultant reported in 1955 that, for mechanization and efficiency, opencast operations in the United Kingdom now compare favorably with those in the United States where the strip mining counterpart commenced in 1885 and is responsible for one-third of that country's present-day coal production.

Details of the most ambitious opencast undertaking yet attempted might be cited here. Preliminary work began in 1955 on a 1000 acre site lying some four and a half miles southeast of Loch Leven on the borders of Fife and Kinross in south Scotland. Excavations are expected to reach a maximum depth of 700 feet and a total of 20,000,000 tons of coal will be removed over a working life of 20 years. Restoration of the land to its original level is out of the question and it has been agreed that 200 acres, largely bog land at present, will be flooded to form a new loch.

[17] Ministry of Fuel and Power Statistical Digest, 1955, H.M.S.O., Table 49, p. 71.

[18] National Coal Board: Report and Accounts for 1955, p. 7.

[19] Ministry of Fuel and Power Statistical Digest, 1955, H.M.S.O., Table 52, p. 73.

The yield of coal per acre of excavated land varies between wide limits, but 5000 tons appears to be a reasonable average. Some 2500 acres of new land will thus be required annually for coal getting if the present output level is to be kept up. About double this acreage will be in need of restorative treatment since adjoining sectors of the requisitioned land are needed for storage purposes and the temporary dumping of overburden or waste rock. Wherever practicable, restoration of the land after working is in accordance with the improved code adopted in 1951. Great care is now taken in this final episode of the opencast working cycle and in some instances it is claimed that the land is restored to agricultural use in a better condition than previously. Opencast mining is efficient in that it provides for a 100 per cent extraction of the available reserves under any particular site; its short-term repercussions on agricultural pursuits may be drastic, but it is likely to cause less permanent harm than shallow drift or slant mining which over the years may produce deep subsidence pocking and local flooding. In 1955 the net profit to the Board of opencast operations was £4.7 million or 8/4d a ton of coal produced.[20]

DIFFICULTIES FACING THE REHABILITATION OF THE INDUSTRY

The National Coal Board took over an industry which had been diminishing for more than a quarter of a century. The root cause of this decline was a fall in demand especially for the export and bunker trade. The incentive for capital investment was largely absent, the number of new major schemes was strictly limited, mechanical advancement was seriously retarded and the industry was starved of qualified technical staff. The Board were faced with the tremendous task of drawing up and implementing a program that would reverse this down-hill trend.[21]

As an extractive industry coal mining consumes itself with extended working so that the imperative need and the first call on any new investment is the replacement of lost capacity. The wastage of capacity in 1955 totalled 4 to 5 million tons. The full length of working faces in the British coal fields amounts to about 440 miles; these are being advanced at an average rate of approximately 220 yards per annum so that some 35,000 to 40,000 acres of coal seams are annually extracted. This high rate of removal has meant that coal faces have progressively moved farther from the shafts, the better quality and more accessible seams have been, or are becoming, worked out; and many pits or even whole areas are being exhausted of reserves. Since good seams give on the whole better opportunities for new mining techniques than poor seams, the difficulties to be overcome in applying mechanization are thus annually becoming greater. As an example of this process of exhaustion the famous Top Hard Seam of Nottinghamshire, even in the newer parts of the coal field, is rapidly being worked out at some pits so that the continuance of these is dependent on the extraction of less economic seams. In 1938 only about 15 per cent of the coal output came from seams containing more than 10 per cent of dirt bands; in 1953 about 30 per cent of the production was drawn from such seams.[22] Each year the extraneous matter removed from the coal raised and weighed increases

[20] National Coal Board: Report and Accounts for 1955, p. 7.

[21] Investing in Coal, Progress and Prospects under the Plan for Coal, National Coal Board, 1956, p. 7.

[22] National Coal Board: Report and Accounts for 1953.

by about ½ per cent—roughly 1 million tons—and has to be made good before salable output is maintained.[23] In 1955 the average depth of workings was some 390 yards. In the future the Board will have to go deeper for their coal; all the new pits begun or authorized since 1946 will work coal deeper than 600 yards.

Less than one-tenth of the present coal output is won from pits opened up in the period 1913–1947 and more than two-thirds is derived from pits started during the nineteenth century. The proportion of the output obtained from pits with limited reserves and anticipated short lives varies from about 30 per cent or more in the Scottish, Lancashire, and South Wales coal fields to nil, or practically nil, in the Yorkshire, Derbyshire and Nottinghamshire, and Kent coal fields. Schemes of reconstruction must be undertaken in many of these solely to keep the colliery in existence, there being little or no hope of increased production.

The scope for new collieries in virgin areas is rather limited, and for obvious reasons much of the shallow coal has now largely been worked out. Such shallow coal as remains can be opened up quickly by drift mines, and this means of coal getting will be employed in many of the older coal fields, particularly in Scotland and Durham. The development of a new colliery today is a very large and costly undertaking with overheads ranging up to £15,000,000 or more. Greater knowledge of geological structure providing a clearer picture of the extent and workability of reserves is a prime necessity in justifying such heavy expenditure. It may take 10 to 12 years before a new large unit of this type is brought into full production. A major reconstruction of an existing colliery may also involve six to eight years' work, and throughout this period the need for maintenance of current output often gets in the way of reconstruction and vice versa. Much of the geology of the shallower coal-bearing strata was formerly deduced from adjoining exposures, and where these were masked by superficial deposits greater risks could be taken since the shafts were not very deep and small pits were then economic. To supplement existing geological information, about as much deep boring is now being undertaken in one year as the coal industry did in 20 years before nationalization. New producing units have to be larger than formerly and the provision of capacity at depth is much slower than from shallow reserves. In certain coal fields, as in Nottinghamshire, to get at the deeply concealed coal-bearing beds, new shafts must be sunk through several hundreds of feet of very heavily watered Permo-Triassic strata which necessitate special drainage precautions such as the employment of the freezing innovation. With this a freezing agent is continually circulated around the shaft until it is waterproofed after non water-bearing measures are reached.

In southeastern Scotland, Cumberland, and northeastern England important reserve areas are located under the sea (Fig. 12). To reach these undersea coals a heavy capital outlay is required owing to the amount of non-productive work which must be done to make the coal available. For any extended undersea workings it is also essential to obtain accurate knowledge of the nature and thickness of any loose unconsolidated materials overlying the coal-bearing strata. Geophysical investigations have been carried

[23] Address by Sir Hubert Houldsworth, Chairman, National Coal Board, at the Annual Conference of the National Union of Mineworkers, Blackpool, July 7, 1954 (pamphlet published by the National Coal Board, p. 8).

FIG. 12. New shafts of the Seafield Colliery, East Fifeshire, October, 1956. This new colliery will work extensive reserves below the Firth of Forth. (Photo by National Coal Board.)

FIG. 13. Undersea boring tower in the Firth of Forth. The tower is resting on the sea bed and the drilling rig is contained in the pyramid-shaped structure on the top deck. (Photo by National Coal Board.)

out to determine by seismic methods the rock-head contour across potential reserve areas. A deep, underwater bore hole involving the special construction of an off-shore boring tower, the first to be tried in the United Kingdom, has been put down in the Firth of Forth (Fig. 13).

In many of the older coal fields earlier mining ventures were extremely wasteful of resources and the haphazard retention of coal pillars is now handicapping many reconstruction schemes which are aimed at the extraction of adjacent seams. The de-watering of old workings is also a major problem which slows down and adds to the cost of renewed or intensified mining. Extensive pumping operations have been carried out in the west of the Durham coal field so that the water table has been lowered by about 150 feet and thus liberating large areas of coal previously impossible to work.[24] In this same coal field the majority of the seams are of too hard a nature to permit the installation of coal plows. It is confidently hoped that these plows are the answer to the problem of the economic working of the thin seams in this coal field in which it is estimated there are reserves of some 779 million tons of coal, a good proportion of which is the famed coking coal.[25]

Great though the physical difficulties may be, one of the major problems facing the future well-being of the industry is the recruitment of additional man power or even the retention of the existing labor force. In 1955, man power within the industry fell by more than 5604 compared with the previous year, and production was badly affected by strikes and restrictive practices, especially in the Scottish, Yorkshire, and South Wales coal fields. At the end of the year it was estimated that the industry needed 13,000 more men—about 9000 of them in the North Eastern, West Midlands, and South Western Divisions, the shortage of labor being particularly acute in the West Midlands coal fields.[26] It is all too apparent that there is need of greater discipline in the pits; in recent years well over a million tons of coal have been lost annually through unofficial stoppages and periods of unrest. Better conditions of working such as shorter shifts, five-day weeks and longer holiday periods will defeat their own objective if not offset by increased productivity and honest endeavor by each individual worker.

Intensive dust suppression measures are being actively pursued to combat the scourge of pneumoconiosis. For the three years 1953 to 1955, inclusive, the numbers of new cases of the disease diagnosed under the National Insurance (Industrial Injuries, Prescribed Diseases) General Regulations, 1948, have annually totalled 4000 to 5000. Comparing each coal field, although the numbers have been reduced, miners in the South Wales field are still the chief sufferers in this respect.[27]

PLANS FOR THE FUTURE

In October, 1950, the National Coal Board published their original "Plan for Coal" in which were set out their proposals for the reconstruction and development of the industry until 1965. The Plan was based on a painstaking survey of 950 collieries but, nevertheless, it was emphasized at the time that this was very flexible and would

[24] Reports of H.M. Inspectors of Mines, Ministry of Fuel and Power, Northern Division, 1953, p. 3.

[25] *Ibid.*, 1952, p. 2.

[26] National Coal Board: Report and Accounts for 1955, p. 33.

[27] Ministry of Fuel and Power Statistical Digest, 1955, H.M.S.O., Table 44, p. 62.

be in need of repeated revision. The annual output of deep-mined coal which would be required in 1961–65 was estimated at about 240 million tons. This represented an increase of 37 million tons over the 1949 output. To achieve this it was proposed that more than 250 collieries should be reconstructed, some 20 new large collieries and 50 new drift or surface mines should be opened, about 250 collieries should remain basically unchanged apart from minor mechanization, while the remainder of the 950 would either be closed or absorbed in the reconstruction schemes. It was reckoned that on completion of the reconstruction program the industry would require 80,000 fewer mine workers than the 698,000 employed in 1950. Based on mid-1949 prices the total cost of this reconstruction program was calculated at £635 million.

By the autumn of 1955 the experience gained in the first five-year period of this program had brought a growing realization of the physical difficulties and costs involved and of the problems arising from man power availability and distribution in a period of full employment. The time was ripe for a rigorous review of the 1949–50 estimates. The revised scheme provides for an output of coal from all sources—including opencast—of 228 million tons in 1960 and 240 million tons in 1965.[28] The conclusion is reached that an output of 250 million tons a year cannot be attained before 1970. To achieve the output for 1960 and 1965 it will be necessary by the end of the latter year not only to complete the vast majority of the major reconstruction schemes now in progress but also to start and complete over a hundred more. The National Coal Board estimates that the capital cost of achieving these output figures and of providing the money for major schemes started before but to be completed after 1965 will be £860 million for collieries and their associated activities. In addition they propose to spend £140 million on ancillaries. Reconstruction in 1950–55 has already cost the Board £353 million. Thus instead of the £635 million estimated in "Plan for Coal" (at mid-1949 prices) the total investment needed in the industry over the 16 year period from 1950 to 1965 is now calculated to be about £1350 million at current prices. Three major factors have determined this increase—the general rise in prices since 1949, the inclusion of additional major projects, and the modification of many of the original schemes planned. It is hoped that this heavy expenditure will effect a substantial increase in the industry's productivity.

In this latest plan it is calculated that the industry will require a labor force of 682,000 with an output a man year of 319 tons in 1960 and 672,000 with an output a man year of 342 tons in 1965. The reduction from the present man power level is not expected to lead to unemployment in any coal field as the decrease will be brought about by natural wastage exceeding recruitment. It is hoped that surplus miners in any of the declining coal fields might be persuaded to transfer to the divisions, such as the West Midlands, which suffer from a labor shortage. It is stressed by the Board that the anticipated output figures are dependent on the two main assumptions that the effective working hours will remain as at present and that the requisite man power will be recruited for the right places.

[28] Investing in Coal, Progress and Prospects under the Plan for Coal, National Coal Board, April, 1956.

TABLE II

ESTIMATES OF SALABLE OUTPUT AND MAN POWER FOR 1960 AND 1965 COMPARED WITH ACTUAL SALABLE OUTPUT AND MAN POWER IN 1955*

Division	*Actual output 1955 (million tons)*	*Estimated output 1960 (million tons)*	*Estimated output 1965 (million tons)*	*Actual man power 1955 (1000's)*	*Estimated man power 1960 (1000's)*	*Estimated man power 1965 (1000's)*
Scottish	21.7	24.0	26.5	82.7	87.0	85.5
Northern	13.4	14.5	14.8	46.8	45.9	44.0
Durham	25.4	24.3	24 0	101.6	93.7	90.0
North Eastern	43.5	46.4	50.0	138.9	134.5	135.0
North Western	15.4	14.2	13.5	58.2	53.6	48.5
East Midlands	45.8	49.0	52.7	101.5	105.7	110.0
West Midlands	17.4	17.2	18.5	56.7	50.1	50.0
South Western	23.8	24.7	26.0	105.6	99.8	97.5
South Eastern	1.5	1.7	2.0	6.7	6.5	6.5
Total for N.C.B. mines	207.9	216.0	228.0	698.7	676.8	667.0
Licensed mines	2.3	2.0	2.0	5.4	5.4	5.4
Opencast	11.4	10.0	10.0	.....	.....	.....
Total for U.K.	221.6	228.0	240.0	704.1	682.2	672.4

*Based on Tables 4 and 6 in "Investing in Coal." National Coal Board, 1956.

PROSPECTS FOR INDIVIDUAL DIVISIONS OR COAL FIELDS

In the Scottish Division the output of the declining Central coal fields is to be replaced by new productive capacity in the Lothians, Fife, Clackmannan, and Ayrshire. Several new shafts will be sunk; in addition new shafts have been, or are being, sunk at six existing collieries. Together these sinkings, when completed, should provide over eight million tons of coal a year. Major reconstruction and the sinking of a new shaft at Valleyfield colliery in West Fife will eventually produce 3600 tons of salable coal per day mainly from under the Firth of Forth where there are nine workable seams ranging up to 120 inches in individual thickness. Reserves within the operational area of this colliery have been estimated at 114,000,000 tons. In the East Fife coal field an area of undersea reserves will be worked by the new Seafield colliery, located to the south of Kirkcaldy. Mining horizons will be driven for a distance of about two miles under the Firth of Forth to cut the coals at depths suitable for working. Another new major sinking in the East Fife area is that of Rothes colliery which will exploit some ten square miles of deep reserves in the Limestone Coal Group to the north of Kirkcaldy.

By 1965 seven collieries will have been reconstructed in the Northumberland coal field and three new surface drifts will be in full production. One of the most impressive reconstructions being undertaken is that of Lynemouth colliery; an undersea reserve of more than 100 million tons is to be worked at the rate of 1,500,000 tons per annum. A network of horizontal roadways will be driven out to a distance of three miles under the sea. It is hoped to raise the overall output per man shift here from 25.8 cwts. salable in 1947 to 54.7 cwts. salable in 1958.

A slow decline in output is now regarded as inevitable in the Durham coal field. Reserves are fast diminishing on the western side but the uncertainties out to sea on the eastern side make it impossible to predict the degree of this overall decline. Seven new

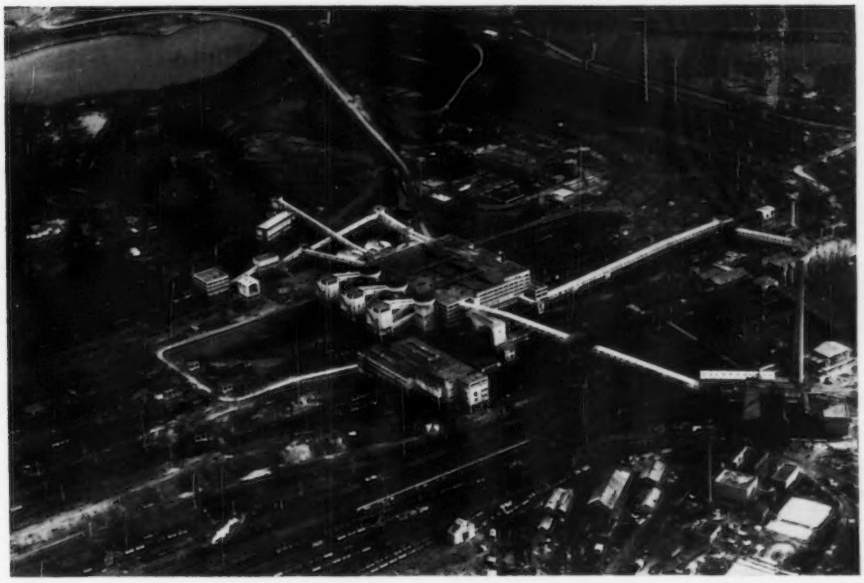

FIG. 14. The new coal preparation plant at Manvers Main Colliery, near Mexborough, West Riding, Yorkshire. (Photo by National Coal Board.)

FIG. 15. Nantgarw Colliery on the South Crop of the South Wales coal field. This constitutes a major reconstruction of a former disused shaft. (Photo by National Coal Board.)

drifts were brought into production in southeast Durham in 1954; these will help to maintain output and will provide employment for miners rendered redundant in the older parts of the coal field. The exceptionally high quality of the Durham coking coals and their importance to the carbonization industries will necessitate the continued extraction of thin seams which elsewhere would be regarded as uneconomic to work.

The North Eastern Division is one of the two most important in the country. To raise output in 1965 by more than six million tons above its present level it will be necessary to complete more than 40 major reconstruction schemes. Work is expected to start in the near future on a new colliery at Kellingley.

The Lancashire coal field has been heavily worked in the past and is going to lose much of its present capacity in the next ten years so that a diminishing production is unavoidable. An intensive boring program has proved the presence on the northwest side of Manchester of coal reserves exceeding 100 million tons at depths between 1200 and 3500 feet.[29] To exploit these a new sinking has commenced on the site of the old Agecroft colliery and is scheduled eventually to produce 4000 tons of salable coal per day. A further new colliery at Parkside is expected to start shortly. No new sinkings are envisaged for the North Wales coal field but it is hoped to maintain output at about the present level.

Output from the important East Midland Division is expected in 1965 to be seven million tons above the present level. Four new major collieries are scheduled for eventual sinking, work on two of which was in progress in 1956. Bevercotes colliery in Nottinghamshire, the first new colliery to be planned in this Division since nationalization, will be sunk to a depth of 3000 feet and will work reserves calculated at 113,524,000 tons, including 37,629,000 tons in the famous Top Hard Seam. In addition to these new sinkings a new shaft has been sunk at Calverton colliery, seven miles to the northeast of Nottingham; a labor force of 2000 will be required to man this and the reserves available are expected to last for 100 years.

In the West Midlands coal fields, the major problem facing the reconstruction program and the anticipated increased output is the shortage of labor. There exists a great potential for new sinkings in the North Staffordshire area. The sinking of the new Lea Hall colliery near Rugely in Cannock Chase has made good progress and may be followed by another new sinking in this vicinity. New pits are also possible in Warwickshire and Shropshire.

For a number of years there has been conflict between men and management resulting in loss in output in some parts of the South Wales coal field. The physical conditions of mining are also difficult, but this coal field assumes special importance because of the high quality of its constituent coals—anthracite and dry steam coals as well as coking coals. Two large new pits in the anthracite section of the coal field are well under way and in other parts of the coal field several major reconstructions and amalgamation schemes are nearing completion. A new pit at Margam on the South Crop of the coal field, where there are large reserves of high-grade coking coal, is a strong possibility. The production of anthracite is expected to increase by

[29] Reports of H.M. Inspectors of Mines, Ministry of Fuel and Power, North Western Division, 1953, p. 1.

over half a million tons by 1965, but the level of future output from this coal field is difficult to forecast with certainty.

No decision has yet been taken on the possibility of a new pit for the Kent coal field. Major reconstructions at all four collieries are expected to effect a slight increase of output.

RECONSTRUCTION SCHEMES AND NEW PROJECTS UNDERTAKEN BY THE END OF 1955

From nationalization of the coal industry until the end of 1955 there were 179 major reconstruction schemes (including 12 separate coal preparation plants), at a cost of more than £250,000 apiece, completed or in progress.[30] Total capital expenditure on these major schemes reached £128,000,000 and since nationalization a further £195,000,000 had been spent on smaller reconstruction schemes and on routine plant replacements throughout the industry. The Divisions showing most major schemes are the North Eastern, Scottish, and East Midlands, in that order. These, for the most part, concern existing collieries but 14 are new pits, 12 are new surface mines or drifts, and four are reopenings of disused collieries. Two reopenings, five surface mines and 13 major reconstructions had been completed by the end of 1955. Output from these units during the year totalled 9.1 million tons as compared with 6.3 million tons in 1947.

Many of the major reconstructions aim at improvements, including mechanical handling, in the underground transportation systems. In those coal fields or areas where the coal seams show an appreciable dip, good progress has been made in the driving of new horizon tunnels which will form the basis of permanent underground roadways for the movement of both men and coal. Other schemes are amalgamation projects which, it is hoped, will lead to a more economic extraction of the remaining reserves at two or more adjoining collieries. The degree of mechanization of coal faces has increased considerably and several electrification programs have been finished.

In nearly every major coal field, individual collieries, which have been subject to major reconstruction, have shown encouraging improvements in the level of productivity. Many show outputs per man shift (overall) of more than 30 cwts. compared with previous outputs of 20 cwts. or less. In exceptional cases this new level of productivity has exceeded 50 cwts. and is a measure of what can be achieved in many of the new sinkings.

The numerous minor schemes completed have helped to maintain the industry's capacity but it is generally true to say that the major reconstructions are the only source of new capacity. Increased mechanization and general improvement throughout the industry have raised output by 12.5 per cent between 1947 and 1955 in spite of the tendency for capacity to diminish. For the future the replacement of this lost capacity and most of the positive gains in output and efficiency must come from the major schemes.[31]

ATOMIC POWER AND THE FUTURE DEMAND FOR COAL

It was stated by the Minister of Fuel and Power in the House of Commons on February 13, 1956, that the demand for all forms of primary fuel in Britain

[30] National Coal Board: Report and Accounts for 1955, p. 11.

[31] Investing in Coal, Progress and Prospects under the Plan for Coal, National Coal Board, 1956, p. 11.

FIG. 16. Mardy Colliery, South Wales coal field. After major reconstruction this unit will work a reserve area estimated to contain 150,000,000 tons of dry steam coal. (Photo by National Coal Board.)

in 1965 may exceed 300 million tons of coal equivalent compared with the 1955 consumption of 250 million tons.

An increasing demand for energy is axiomatic to a healthy and expanding economy. Just how rapid this increase will be is difficult to assess; estimates have ranged between 1½ per cent and 3 per cent per year.

At a recent Atomic Energy Conference at Geneva it was suggested that by the end of the century Britain would be using between two and a half and three and a half times as much energy

as she does now.[32] It was also forecast that atomic energy might by then contribute half of the required energy supplies. This would still leave the need for 310 to 440 million tons of coal equivalent from the conventional fuels —coal, oil, and hydroelectricity. The use of oil can be expected to grow rapidly, although difficulties of supply may well curb the degree of increase. A nuclear power station, opened in 1956, already supplies small quantities of power to the National Grid and from about 1960 onwards these stations will contribute increasingly larger proportions of the country's energy requirements. Notwithstanding this, on present knowledge, there seems little fear of problems of overproduction in the coal industry arising within the present century at least. Inland demand for coal has continued to rise so rapidly in the past ten years that this is likely to more than offset for many years to come any surplus supplies arising from increasing use of atomic power. The possibilities of large quantities of coal being available for export as in the earlier part of this century seem very remote indeed.

[32] E. F. Schumacher: Investment in Coal, N.C.B. Summer School, Oxford, September, 1955.

WATER LEGISLATION

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WITH an estimated per capita use of water in the United States of about 1200 gallons per day and with continually increasing demands, there is certainly need for state regulations defining and delimiting the rights of individuals and corporations in the utilization of this precious resource. In many sections of our country agriculture, municipalities, and industries are competing with one another for appropriative rights, and when there is not enough water to satisfy current or prospective needs it becomes paramount to know how the available supplies are to be allocated. This is especially true in the humid eastern half of our country where the principle of riparian rights remains the basic law of the land. In many of the 31 eastern and southern states legislative committees have already been set up to study the advisability of modernizing the existing water laws and at least eight states have adopted preliminary legislation governing the use of surface streams. Although such legislation is still relatively novel in the states lying east of the 20-inch rainfall line, they can well profit from the trials and experiences of the western states in which water legislation has evolved for more than a century.

It would take a "Philadelphia lawyer" to untangle all the intricacies of the law; therefore, in this short essay the aim is to present only the major features of the various water rights now in use, especially as they pertain to irrigation, inasmuch as supplementary irrigation is being increasingly applied in the humid sections of our country.

A water right is essentially a right to the use of water, the so-called "usufructuary" right.[1] It is based on the physical law that water by its very nature is a mobile substance; a truth which is also expressed in the old saying that "you can't swim the same river twice." Hence, no one really owns running water, *per se*. However, if a person has the right to divert the water from its natural environment and uses it, then it follows that in the lawful exercise of that right water becomes his private property and as such is entitled to protection by the courts against infringement. Water rights are not limited to surface streams; they also apply to waters under the surface.

Surface Waters

There are two basic doctrines controlling the use of water: the riparian or common law rule and the prior appropriation doctrine. The former recognizes that lands contiguous to streams have certain rights in the flow of water solely because of their location, while the latter accords priorities in order of taking water for use on land regardless of its contiguity to the stream. As far as the United States Supreme Court is concerned, each state has the

[1] R. E. Huffman: *Irrigation Development and Public Water Policy*, New York, 1953, p. 38.

TABLE I

COMPARATIVE WATER RIGHTS

Riparian Doctrine	*Appropriation Doctrine*
1. Riparian rights are inherent in the land and are acquired by acquiring title to the land.	1. Appropriation rights are acquired by statutory procedures and usually placed under the supervision of the State Engineer.
2. Land must be contiguous to the stream.	2. Contiguity to a stream is not a criteria.
3. Can divert water for "natural uses" as long as it does not interfere with similar rights of other riparian owners.	3. First in time can withdraw as much water as is needed for "beneficial" uses regardless of the needs of others.
4. Is not limited to a specific quantity of water.	4. Sets a definite quantity of water allocated; also may be limited to a certain time of the year or even to certain hours during each 24-hour period.
5. Does not lose rights with non-use.	5. Loses rights with non-use.

prerogative to adopt or reject any or both rules.[2]

The basic and fundamental differences between the two doctrines have engendered a long history of litigation and have brought about drastic modifications in water rights legislation. It is of interest that the origins of both doctrines can be traced back to the early civilizations in the Mediterranean area. The doctrine of riparian rights was introduced into this country by two devious routes: (1) by way of France and England to our eastern seaboard[3] and (2) by way of Spain and Mexico to Texas. The appropriation doctrine claims its origins in the civil law of Rome and was practiced locally in many Spanish settlements of the Southwest. Later, the gold miners in California and the Mormons in Utah simply took whatever water they needed for their operations. In 1866 Congress passed an Act which permitted the appropriation of water from a stream for use on public domain, provided it did not interfere with the navigability of navigable streams. Because at that time most of the land in the West was federal land, this ruling became a powerful factor in the spread of the appropriation principle throughout the West. Table I is an attempt to point up the major differences between the two doctrines in tabular form.

Clearly, then, the doctrine of riparian rights as adopted by the humid sections of western Europe and eastern United States was primarily aimed at maintaining the unrestricted flow of water in surface streams, an item of great significance where rivers were used for navigation. Every riparian owner was entitled to the "free and uninterrupted flow of water, undiminished in quantity and unpolluted in quality." The so-called "natural use" of water implied that a person could take water for household and such domestic uses as were necessary for the sustenance of the family, but he could not divert water for "artificial" or "extraordinary" uses which included water for irrigation, industrial, and recreational purposes. Floating logs or turning the wheels of a

[2] In settling interstate water controversies the U. S. Supreme Court has applied the principle of equitable apportionment. Report of the President's Water Resources Policy Commission, Vol. III, *Water Resources Law*, Washington, 1950, p. 167.

[3] Before it became a part of the English common law and as such adopted by most of our states, the British had actually taken it from the writings of two American jurists, Story and Kent, who in the early part of the nineteenth century had expounded the doctrine as it was embodied in the civil laws of France. See Wells A. Hutchins: "History of the Conflict Between Riparian and Appropriative Rights in the Western States," paper presented at the Water Law Conference on Riparian and Appropriative Rights, University of Texas School of Law, Austin, Texas, June 11–12, 1954, pp. 1–2.

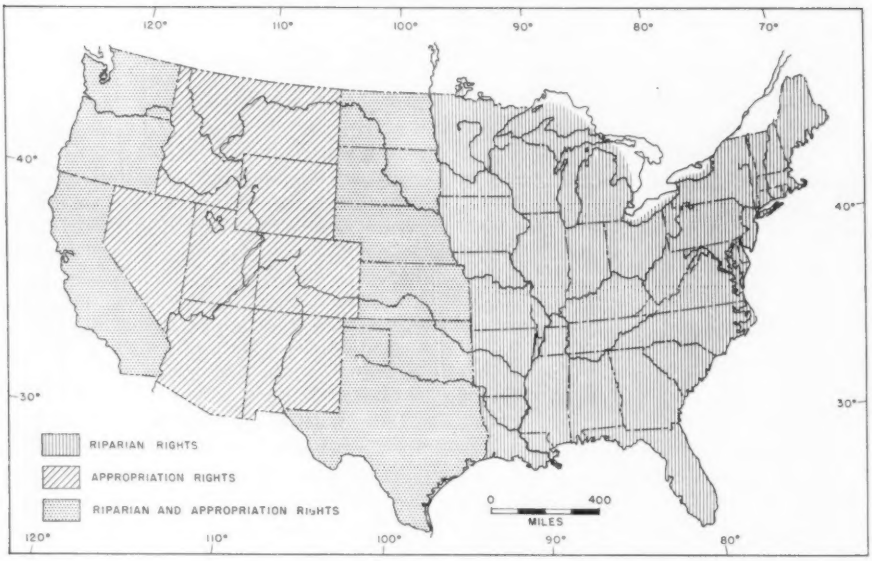

FIG. 1. Water rights in the United States.

mill were non-consumptive uses and not contrary to the spirit of the law. In contrast, under the doctrine of prior appropriation the right to divert water from a stream for beneficial purposes was a recognized practice based on the "first in time, first in rights" principle. This rule became firmly entrenched in the arid sections of our country where irrigation was absolutely essential to any permanent agriculture.

Figure 1 shows the distribution of the two doctrines among the 48 states. In the arid heartland where water is state or public property the appropriation doctrine is the only one recognized by the courts. Colorado was the first state to repudiate the riparian doctrine. That was in 1882. Nevada followed suit in 1885; Arizona, in 1887; Idaho, in 1888; New Mexico and Utah, in 1891; Wyoming, in 1896; and Montana, in 1921.[4] The two doctrines exist concurrently in the Pacific and in the 100th meridian states, all of which have humid and dry sections within their boundaries. However, the riparian doctrine in those nine states has been modified to the extent that diversion of water for irrigation is a recognized riparian use, although it took a constitutional amendment in California to prohibit the waste of water and limit the riparian rights to reasonable and beneficial use. At times the courts have been asked to decide what constitutes "beneficial" use. For instance, using water to drown out gophers in areas where water is needed for irrigation is not considered a beneficial use.

Irrigation rights under the riparian principle are co-equal with the rights of all other riparian owners on the stream. If the quantity of water in the stream is not enough to satisfy crop requirements of all, it is subject to apportionment among the individual owners upon some equitable basis. The conflict between the riparian appropriator and the non-riparian appropriator in those nine dual-rights states

[4] *Ibid.*, pp. 8–10, 22.

centers primarily around the question of unused riparian rights, for it is generally recognized that the riparian owner has superior rights in that his claim has priority. If the riparian owner fails to make beneficial use of the water within a reasonable period of time, his priority right for future appropriation may remain of the same validity as at present, or that right may be confiscated in favor of the non-riparian appropriator (e.g., in Oregon). If he retains his superior rights it guarantees him preference over the non-riparian appropriator regardless of the time he commences irrigation (e.g., in California).[5]

UNDERGROUND WATERS

Usually a distinction is made between underground water flowing in definite streams and percolating waters. Where underground streams are present the same rights governing surface streams apply to the subterranean channels. Generally speaking, ground waters are presumed to be percolating waters and are subject to a variety of regulations. The riparian doctrine or the English common law rule accords to the owner of the overlying land the absolute ownership of percolating water existing in his land on the same basis that the rocks and minerals under the land are his.[6] This right is sometimes referred to as the "doctrine of unreasonable use." It gives the owner the right to dig deeper wells even though it means withdrawal of water underlying his neighbor's property for the sole reason that his neighbor has the same right. Such a situation was dramatically illustrated in Fond du Lac, Wisconsin, where the city sought to increase its water supply by tapping the ground water supply in the rural area. The farmers in the local township objected to the pumping stations because of the adverse effect they would have on the water table, and were afraid their wells might go dry. A zoning ordinance to keep out the pumping stations was set aside by the courts which ruled that under existing laws the city was entitled to all the water it could get from under its own land.[7]

Two modifications of the riparian rights which are inherent in land ownership are the "rule of reasonable use" and the "correlative rights doctrine." The former is also known as the American doctrine in contrast with the English common law rule because the landowner's rights in the water underlying his property are not unlimited. His right to use the water is prescribed by the area from which the water is withdrawn and prohibits waste or exportation of water for use in another area. The doctrine of correlative rights, which originally was developed in California, allocates to the owners of lands overlying a common supply of percolating water a proportionate share of the water according to their respective needs. In some states the doctrine of prior appropriation remains in effect and allows the withdrawal of water for beneficial use regardless of whether the land overlies the ground water supply.

Because in most cases underground water and surface stream flows are interdependent and interconnected, it would seem practical that the same rules apply to both water sources. Recent trends seem to put ground water on the reasonable use basis or to apply

[5] Wells A. Hutchins: "Water Rights for Agriculture," paper presented at the American Association for the Advancement of Science, Berkeley, California, December 27, 1954, p. 6.

[6] Actually this is a refutation of the riparian principle which recognizes the moving nature of water.

[7] R. J. Penn: "Shall We Modernize Our Water Laws?" paper presented at the Wisconsin Farm Bureau Federation, Madison, Wisconsin, November 13, 1956, pp. 4–5.

the same principles of use and administration to ground water as are applicable to surface streams. As yet there is not always that correlation. In Illinois, for instance, the riparian doctrine of reasonable use applies to surface streams, but the English rule of unreasonable use hold for ground water.

CONCLUSION

The trend is definitely toward appropriation, and this calls for effective public control. Flowing water is a public resource, regardless of what system of law prevails, and if regulation is essential to the public welfare, it can be justified as an exercise of the police power of the state with respect to riparian rights as well as to appropriative rights.[8] Where under present laws the riparian owner is in no way obligated to conserve or make beneficial use of the water supply; where he is allowed to waste water or watch it flow to the sea and still maintains his water rights as long as he holds title to the land; then, surely, these resources are not used in the interest of the general welfare. Any contemplated change in water legislation, however, must be based on scientific research, for efficient utilization of the water supply can be attained under either the riparian or the appropriation doctrines, provided the governing principles are adequately defined and applied. The Florida Water Resources Study Commission, for example, feels it advisable "to preserve in so far as possible the existing riparian doctrine in order to permit maximum beneficial use."[9] The major difficulties spring from those concepts of the riparian rights that sanction inefficient and wasteful use of water or the indefinite holding of the right without putting the water to use.

A proposal has been made for a "maximum use" doctrine for the humid mid-continent. It is defined as a "doctrine which provides that a governmental agency estimate the potential needs within various specified watersheds, or general areas, of a state over a future period of time deemed most practical for such purposes."[10] In other words, it recommends the building-up of year-round volumes of water for future use, but it does not specify how this is to be done.

The ever-increasing demands on our water resources have also alerted the organizations primarily interested in fish and wildlife. One of them has come out with the following recommendations: (1) "No law should allow the people, individually or collectively, to so 'appropriate' and divert water from living perennial streams that such streams are dried completely. There should and must be left an irreducible minimum, so as to maintain streams as living waters, capable of sustaining an abundance of aquatic life;" and (2) "No law should permit the flow of streams to be so reduced by appropriation and diversion as to aggravate downstream pollution problems and nuisances."[11] In that case public health becomes an important factor also.

In the final analysis it seems that with such great diversity of interests our courts will remain busy for a long time to come.

[8] Wells A. Hutchins: "Problems in Modernizing Water Laws," paper presented at the Midwestern Flood Control Conference, East Lansing, Michigan, June 15–17, 1954, pp. 14–15.

[9] Personal communication from David B. Smith, Director of the Florida Water Resources Study Commission, December 12, 1956.

[10] Robert W. Kellum: "Review of Indiana Water Resources Program and Comments on Prospective Mid-Continent Programs," paper presented at a seminar on Iowa's Water Resources, University of Iowa, Iowa City, March 26, 1956, p. 5.

[11] "Watch This New Water Law Trend," *Outdoor America*, Vol. 20 (Jan.-Feb., 1955), p. 2.

IGUSA: A CRITICAL CASH CROP IN THE RURAL ECONOMY OF OKAYAMA PREFECTURE*

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THE farmers of the lowlands of the Inland Sea region of Japan are among the most prosperous in Japan and of these the farmers of Okayama Prefecture are outstanding. This prosperity and the high rural standard of living are due to favorable climatic conditions which permit double cropping; good soils, especially on the reclaimed lands known as *shinden* (new fields); advanced farming techniques; hard work; and special cash crops which bring high returns for the amount of land devoted to them. One of the most important cash crops is *igusa* (*Juncus effusus*, L. var. *decipiens*, Buch). This rush is used in making mat coverings or *tatami omote* which are used on the floors of most Japanese houses. It is produced in other parts of the Inland Sea region and Kyushu but Okayama Prefecture has long been the leading producer, both in quantity and quality.

Villages which specialize in raising *igusa* are noted for their high standards of living and general appearances of prosperity. In many of these villages the net income from selling *igusa* is about one-half of that received from rice although only about one-fourteenth as much land may be planted in *igusa* as in rice. Farmers of Okayama Prefecture say that the income from the sale of rice, wheat, and barley pays their taxes and basic living expenses while the extra income from *igusa* provides the luxuries. This extra cash from *igusa* goes far to explain the ability of the farmers of this area to pioneer in the development and purchase of farm machinery to a greater extent than in other parts of Japan. Additional income may be secured by the farm families if they weave the *igusa* into mat coverings in their homes. However, the tendency in the better farming areas is for the farmers to sell the *igusa* unless they have power looms in their homes and to use the time saved for other work or for much needed leisure. The *igusa* that is sold is processed in small factories concentrated in the villages and small towns of the *shinden* lands.

The amount of land planted in *igusa* each year is limited by the short time available between its harvest in the early summer and the planting of the rice crop which follows, the high cost of hired labor, and the uncertainties of the market which fluctuates considerably from year to year and month to month according to political, economic, and weather conditions.

The income from *igusa* is well earned as *igusa* requires backbreaking labor at the most unpleasant times of the year; it is planted in the coldest part of the winter and harvested in the hottest time of summer. Though the fields

*This study is based on field work between June, 1954, and July, 1955, made possible by the University of Michigan Center for Japanese Studies, Okayama, Japan. The author wishes to express his appreciation for the generous aid given him by the people of Okayama Prefecture, especially Mr. Chikao Ueda.

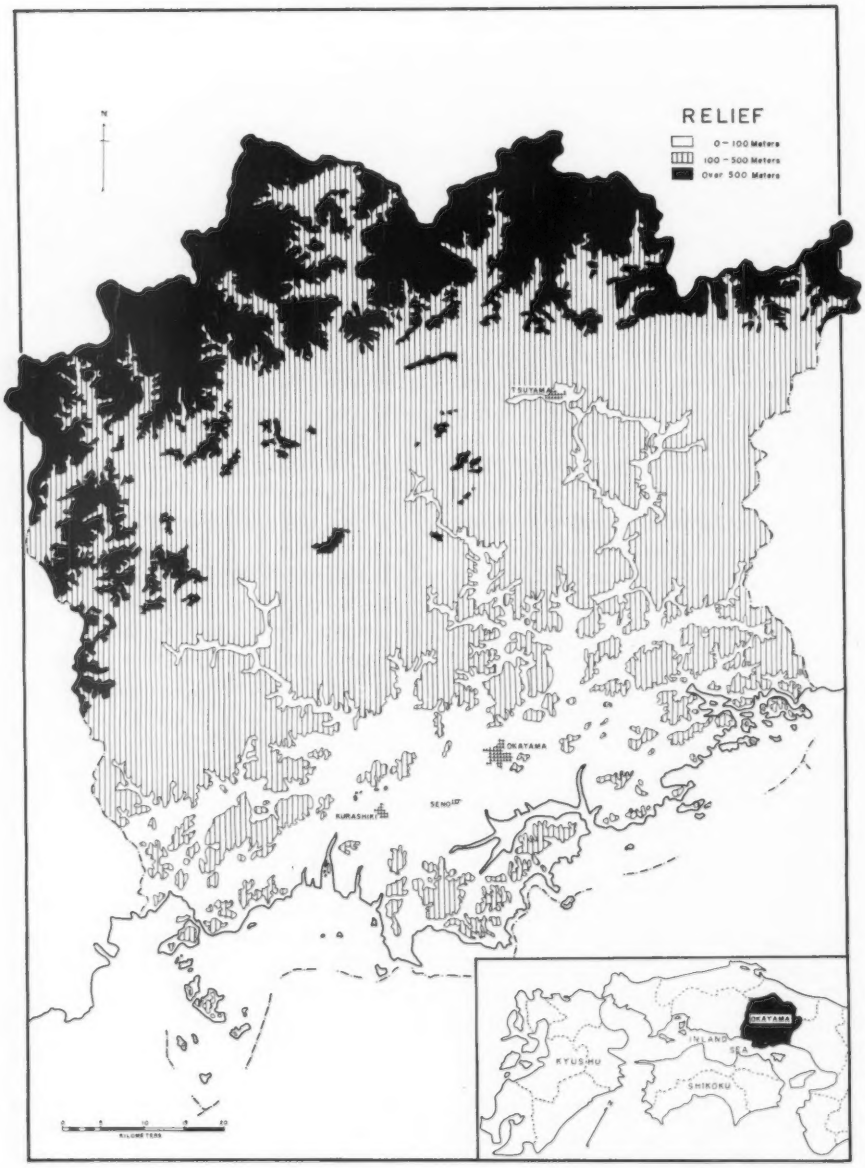

FIG. 1. Relief map of Okayama Prefecture. The higher elevations in the north give protection to the southern lowlands but have too short a growing season for optimum *igusa* production. The insert shows the general location of Okayama Prefecture in western Japan on the Inland Sea.

can be prepared by mechanized hand cultivators, called light tractors in Japan, and the water for irrigation pumped by motors, to date the efforts to mechanize the cultivation, weeding, and harvesting of *igusa* have not succeeded.

USES OF IGUSA

Igusa plays an important part in the everyday life of the Japanese people as it is used as a covering on the floors of most Japanese homes. The rush is woven into a mat covering called *tatami omote* which is filled with straw. The resulting mat, called *tatami*, is placed on the floors in Japanese homes. The floors are so soft that the beds are made on them directly without mattresses. The inability of *igusa* to take concentrated weight without breaking is in part responsible for the lack of furniture which is characteristic of Japanese rooms. To keep the *tatami* clean, shoes are removed before entering the Japanese home.

Tatami are usually about six feet long, three feet wide, and two inches thick.

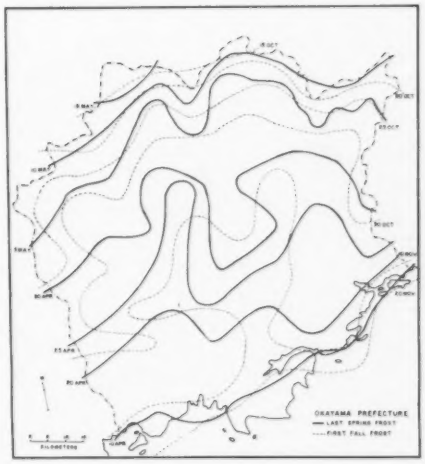

FIG. 2. Dates of latest spring and earliest fall frosts in Okayama Prefecture. The longer growing season of the southern lowlands permits the growth of a rice crop after harvesting *igusa*.

Although this size varies slightly in different parts of Japan, it is uniform in any one locality for general purposes. Thus the *tatami* has become a common unit in Japan for expressing the size of a room, for example, a six *tatami* room. One of the most famous examples of

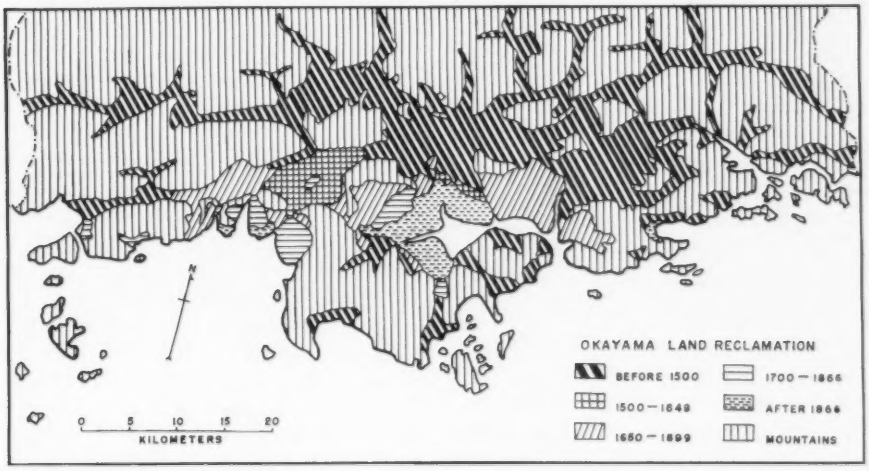

FIG. 3. Dates of land reclamation in Okayama Prefecture. The chief areas of *igusa* production are concentrated on land reclaimed between 1500 and 1866. These areas have fertile soils and lower salt content than the most recently reclaimed lands. (After Hiroshi Ishida.)

splurging in the feudal period was the construction of a thousand mat room.

Igusa is also used in making unstuffed circular and square mats, rugs, curtains, place mats, cushion covers, fans, bottle containers, slippers, paper, and beach mats for the United States.

Shichitoi (*Juncus communis*), another member of the rush family, is sometimes used as a substitute for *igusa*. Although it is more durable, it is not as well liked because of its unfavorable color and texture. In early days it was in common use throughout Japan and is now used in the poorer homes of Kyushu and Shikoku. When there was a shortage of *igusa* during the rebuilding of the Japanese cities after World War II, *shichitoi* was used.

HISTORY OF IGUSA

Rushes were used as floor coverings in Egypt, Medieval Europe, and other parts of the world but eventually were discarded for other types of floor covering. Not only has the rush been retained in Japan, but the making of mats from rushes has been developed into a relatively high art.

Prior to the Tokugawa Period, floor coverings were made from various materials. The usual ones were rice straw or *shichitoi*. Early in the Tokugawa Period the upper classes began using *igusa* which may have been introduced from India by way of China and Okinawa. The mats were earlier known as Bingo *omote* because the first center of *igusa* production was in the province of Bingo, now part of Hiroshima prefecture.[1] However, *igusa* cultivation soon spread eastward to the provinces of Bichu and Bizen, now part of Okayama Prefecture. During the early Meiji Period the use of *igusa* became common among all classes, and today it is the chief floor covering used in Japan.

The income from *igusa* has resulted in changed patterns of land use. Before it became a modern crop about 75 years ago, dry crops were planted on the hills around the *shinden* lands, especially in the older sections, surrounded by mountains, where farmers usually owned both flat paddy rice fields and land with slopes too steep for effective rice terracing. As the cultivation of *igusa* increased in the early Meiji Period and the farmers received additional income from this crop, they were able to concentrate their cultivation on the paddy land and reforest the hills without loss of income. Today with the introduction of motor pumps, motor hand cultivators, light tractors, and power threshing machines, the farmers have additional time available, which is being used increasingly to plant the hill slopes in orchard crops such as pears, peaches, and grapes.

The export of *igusa* mats began in the early 1890's and expanded rapidly. The production and export were furthered by the development of small factories with improved power looms. A temporary setback received when the United States increased import duties on such mats was accentuated by the Russo-Japanese War. Wars and threats of wars have always hurt *igusa* prices. The export business remained dull until the early 1930's. Then *igusa* production increased to meet a rising foreign market and further increased in the late 1930's as prosperity in Japan brought a larger domestic demand.

Okayama Prefecture led the rest of the country in production as it had since early Tokugawa times. Her pre-war peak was reached in 1940 with 8820 acres planted in *igusa*. This represented 60 per cent of the total area of Japan

[1] K. Hayashi (ed.): *Okayama Ken Igyo Hattatsu shi* (History of the *Igusa* Industry in Okayama Prefecture), Okayama City, Iida, 1954.

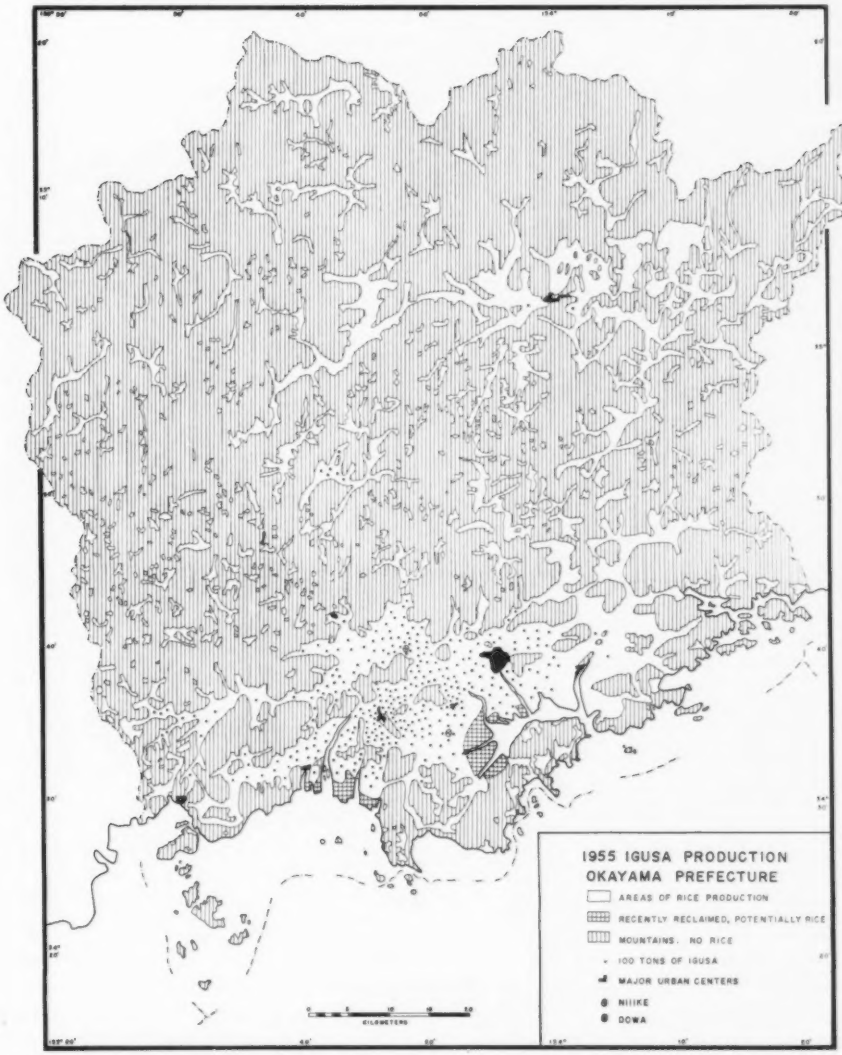

FIG. 4. Distribution of *igusa* production, showing concentration on the reclaimed lowlands of the southern part of the prefecture with some production on interior grabens.

planted in *igusa*. On the outbreak of World War II, the government restricted the planting of non-food crops, including *igusa*. As a result of these controls the land planted in *igusa* in Okayama Prefecture was reduced to 5.86 acres by 1946.

Controls were relaxed in 1946 but not abolished until 1952. During the period of controlled planting, 1946–1952, the allotment of land to *igusa* was fairly liberal since the rebuilding of the war-destroyed cities of the country created a big demand. Other pre-

FIG. 5. *Tatami*, mats covered with woven *igusa*, are used on floors of most Japanese homes.

fectures were encouraged to increase their plantings and did. In the peak year of 1952, Okayama Prefecture's planting reached an all time high of 10,126 acres which now represented only 40 per cent of the total planting in the country. Kumamoto Prefecture was second with 15 per cent of the total planting, followed by Fukuoka and Hiroshima Prefectures with approximately 10 per cent each and Kochi Prefecture with approximately 8 per cent.

In 1954, there was a drop in prices because of an anticipated depression. Although it did not develop, it resulted in decreased plantings.

Although building has slackened and the total production for all Japan has dropped, Okayama Prefecture has been able to hold its own in competition for the remaining market because of greater experience with the crop. Much of the expansion in other areas has been done with the aid of experts from Okayama, but the quality of the reed produced in the newer areas is still considered inferior to that of the older center of production.

The foreign market has also been recovered in the post-war period, but there has been a change in the direction and type of export. Africa has replaced North America as the chief outlet. This is in part due to the appearance of similar mats of greater durability produced in India at a lower price. There is also considerable difficulty in meeting changing American tastes in types and designs. In 1955, British West Africa was the biggest importer of *igusa* mats and the United States second.

DISTRIBUTION OF PRODUCTION WITHIN OKAYAMA PREFECTURE

Within the prefecture of Okayama, production is largely concentrated in the south central section as shown in Figure 4. This area consists of low fertile lands which have been reclaimed from the Inland Sea over a long period of time, as shown in Figure 3, starting at least as early as the eighth century A.D. The southern portion of the prefecture consists of great rift valleys which were once filled by arms of the Inland Sea and separated by horst which were islands. The Kibi Plateau to the north was uplifted and its erosion filled the rift valleys with silt. Man has speeded this process by diking and draining. The reclaimed land is called *shinden* or new fields. Reclamation proceeded rapidly during the Tokugawa Period and at present the last remnant of Kojima Bay is in the process of being made into rice lands.[2]

The concentration of *igusa* in this

[2] John D. Eyre: "Japanese Land Development in Kojima Bay," *Econ. Geog.*, Vol. 32, 1956, pp. 58–74.

FIG. 6. *Igusa* nursery bed in middle of November during rice harvest. Picture shows older reclaimed lands, *shinden*, between Okayama City and Kurashiki.

reclaimed area is explained by the physical and cultural geography of the region. The winter temperatures in the lowlands of southern Okayama are such that the water in the fields does not freeze solid during the planting period although a thin ice crust may form. In the northern part of the prefecture the higher elevations of the Kibi Plateau result in colder winter weather so that ice is common during the winter planting season making it not only unpleasant to plant *igusa* but often physically impossible.

The high elevations also result in later spring and earlier fall frosts as may be seen by a comparison of Figures 1 and 2. This shortens the growing season to a point which makes it difficult to secure a rice crop after harvesting *igusa*. Even under the best conditions on the *shinden* lands, where the last spring frost is mid-April and the first fall frost is early November, the late planting of rice following *igusa* results in 10 to 40 per cent less rice than when it follows winter wheat or barley which mature earlier than *igusa*.

In general the soils of the reclaimed lands of the *shinden* give higher yields of better quality *igusa* than the older soils of the northern basins and flood plains of Okayama Prefecture. Deep, well-drained sandy soils are preferred. Clay soils are sometimes used if they are not too sticky and have good drainage. The *shinden* soils have more natural fertility than most of the upland soils and have not been cultivated as long. According to farmers raising *igusa*, a slight amount of salt in the soils, such as is found in much of the *shinden*, improves the quality of the *igusa*. Too much salt is injurious.

Okayama City and Kurashiki were important administrative centers during

FIG. 7. Type of "light tractor" used in preparing final fields for *igusa*. They are also very important in the short time available in preparing the fields for the rice crop which is planted after the *igusa*.

the Tokugawa Period. Both centers were successful in applying accumulated capital and knowledge of organization and administration in new ways after the Restoration. *Tatami* mat coverings were one of the traditional products of the region which expanded under the new conditions. This trend was aided by the construction of the main railroad line of the Inland Sea area through this region, connecting it with the expanding domestic and foreign markets of Japan's great industrial cities. Industrious citizens of Kurashiki led in the introduction and development of modern machinery applied to weaving *igusa* mats.

While *igusa* became prominent in the central *shinden* area, the eastern and western sections specialized in other cash crops, peppermint and pyrethrum. As peppermint and pyrethrum require attention at the same time as *igusa*, the distribution of these crops has become clearly separated.

CULTIVATION OF *Igusa*

Igusa gives a distinctive appearance to the areas where it is cultivated. During most of the year, whether it is in nursery beds or planted in the fields, its dark green stands out in contrast to the lighter greens and golds of the other fields. For a short period after transplanting it is a rusty brown but this soon changes as the new reeds develop. Near harvest time the tall reeds are often blown over by storms and form wave-like patterns called "seas of *igusa*."

Igusa is uniformly propagated in nursery beds as plants grown from seed do not breed true. The best varieties have been developed for long stem, uniform thickness, absence or small number of flowers, and quality of color. It is replanted each year as stems of the second growth from a harvested field are weak.

Although there are several methods of propagation used in the Inland Sea region, the chief method of propagation in Okayama Prefecture is known as *hachigatsunae* or *akinae*.[3] In this method, nurseries are started on dry fields toward the end of February or early March. Plants left over from the last planting or especially raised for the purpose are separated and planted on especially prepared dry ridges about four or five feet wide. The stems are cut back to a length of about eight inches. The plants are allowed to multiply in these beds until early August. During the first week of August they are again dug up, separated, and planted in wet nursery beds. The nursery beds must be heavily fertilized during both of these stages. As August is a very hot month the water in the fields must be changed every two or three days.

[3] Kekichi Tokunaga (ed.): *Igusa Saibai no Shiori* (A Guide to the Cultivation of *Igusa*), Okayama Prefecture Experimental Farm Institute, Okayama City, 1950, 2nd ed.

FIG. 8. Planting *igusa* in permanent fields. Late December. Near Okayama City.

FIG. 9. Fields of *igusa* in early June. Wheat being harvested, left foreground. Village of Niiike in background.

FIG. 10. Beginning of *igusa* harvest, end of June. Niiike.

Transplanting to the permanent fields, called *honden*, is done between the middle of December and the middle of January in the *shinden* area. In the northern part of the prefecture transplanting to the *honden* may be done as early as the middle of November in order to harvest it in time to secure a rice crop during the shorter frost free season of the highlands. The *honden* are rotated yearly to give them a chance to dry out. They are first carefully prepared by deep spading or with a motor cultivator. In the northern part of the prefecture where the farms are smaller and poorer than on the *shinden*, the work of preparing the fields is still done frequently with a horse or work cow. The soil is turned over to expose it to the air and then irrigated for several days before planting. As in the case of rice this requires careful leveling of the fields and elimination of clods.

When the young plants are dug from the nursery bed, they are divided into sets of six to 13 stems each. About 150 of these sets are tied together in bunches for ease in handling. The number of stems left in a set varies according to the type of soil and the amount of fertilizer the farmer plans to use. Larger sets are left where the soil is good and the farmer plans to use more fertilizer. The bunches are carefully covered with straw mats while waiting in the fields for planting. They can be kept as long as ten days before planting if placed in water and protected from the sun. The spacing between the plants is governed by the amount of fertilizer to be used, the amount of water to be used for irrigation, the time of planting, and the condition of the plants. Under optimum conditions the plants are placed six inches apart. If conditions are not good they may be planted further apart.

At the time of the final transplanting the fields are partially drained, leveled

FIG. 11 (left). Harvesting *igusa*, middle of July. Dipping pit in foreground. Between Okayama City and Kurashiki.

FIG. 12 (right). Hauling dried *igusa* to market. Middle of October. Once *igusa* is properly dyed and dried, it can be marketed at leisure or when the farmer thinks the prices will be best. Road near Niiike.

by the use of draft animals or motor cultivators, and marked off in squares which serve as planting guides. Then comes the most demanding and back-breaking work in the production of *igusa*. The plants are set in the sludge by hand, taking care not to muddy the stems. As this is the coldest season of the year, it is often necessary to break a thin coating of ice; at best the water is near freezing. The laborers' fingers soon are numbed by this cold and lose their sensitivity. Under these conditions it requires considerable skill in order to judge the correct depth for the plants. If they are set too shallow or too deep it retards growth.

Igusa requires 200 days from the time of planting in its permanent fields until it is ready for harvesting. After it is planted in the *honden*, the stems turn brown and there is not much indication of new growth until early March when each plant sends out new stems. The rate of growth begins to increase in April and by the middle of the month the tallest stems have attained a length of about one and a half feet. The number of stems in a clump has by this time increased to about 20 and increases rapidly to double that in May when the stems are cut back to about two feet. By the middle of June each clump has increased to about 80 stems. At harvest time in the middle of July there are about one hundred stems more than two feet in length. The best quality comes from the stems which sprouted in the latter part of May and early June. The ones which sprouted earlier have dead ends by harvest time which reduce their value.

Igusa is free from most of the pests and diseases which cause trouble with rice, barley, and wheat. Rice is less troubled by disease when it is planted after *igusa* than after wheat or barley and less expenditure is required for sprays and insecticides. The chief enemies of *igusa* are grasshoppers or *inago*, and the rush saw fly or *ihabachi*. The grasshoppers are controlled by spraying and burning the grass on the dikes and the rush saw fly by spraying.[4]

More fertilizer is needed for *igusa* than for most crops. It is especially demanding of nitrogen. The usual fertilizers are night soil compost, ammonium sul-

[4] Tokunaga, *op. cit.*, p. 7.

FIG. 13. *Igusa* drying along road near Niiike in early July, an additional hazard on Japanese roads.

phate, calcium phosphate, potassium nitrate, and wood ashes. Before the war, oil cake and fish manure were used more than at present as they are now scarce and expensive. Potassium chloride is sometimes used in place of night soil. In general, sandy soils require more fertilizer than ordinary paddy soils. The skill with which the fertilizer is applied, especially during the month preceding harvest, affects the quality of the rush.

Harvesting begins about the tenth of July and continues in some places until the end of the month. Harvesting means more backbreaking work as the farmers bend over to cut the reeds near the ground with small sickles. The exact date for beginning the harvest is governed by the location and the weather. It usually starts on the *shinden* lands about the tenth of July but may be delayed as late as the twentieth of the month because of weather conditions. The farmer prefers to harvest the crop just as it reaches the best degree of hardness and color. If cut too early or too late the quality and therefore the price are reduced. However, the farmer is under pressure to cut as early as possible so as to give the succeeding rice crop a longer growing season. Even when the *igusa* is harvested and the rice transplanted by the middle of July, the rice yields will be reduced. This critical time is an important factor in encouraging the farmers to purchase motor cultivators which shorten the time needed to prepare the fields for rice plants which have been already too long in their seed beds. Because of the time saved by using a motor cultivator, farmers report that the amount of rice lost by having a preceding crop of *igusa* is cut in half.

In cutting, the farmer grabs a clump of *igusa* with his left hand and cuts the reeds with a sharp sickle held in his

FIG. 14. *Igusa* drying in farm yard. Every bit of available land is pressed into service. Late July. Near Okayama City.

right hand. After the farmer has cut about 15 or 20 clumps he shakes the bundle vigorously to remove the shorter stems and weeds. It takes a good man four or five days to cut one *tan* (.245 acres). Bad weather may prolong the harvesting, and result, after an unusually bad year, in a complete loss. This has not happened in Okayama in the post-war period, but the farmers are very conscious of its having happened in the past.

The bundles from which the weeds and shorter stems have been removed are taken quickly to a dipping pool prepared with water and clay. The clay leaves a coating of fine powder which helps the *igusa* dry evenly and fixes the color, a light green being considered best. The dipping pool or *sometsubo* is a temporary construction about two feet deep and three by five feet wide. A special type of clay of high lime content is usually imported from Akashi in Hyogo Prefecture. This clay gives better color and contains less sand than the local Okayama clays. About 827 pounds of Akashi clay is required for dipping the *igusa* from one *tan* while at least 1240 pounds of local clay is required for the same amount.

During the harvest season every bit of available dry land near the fields is pressed into use—farmyards, river banks, schoolyards, paths, small roads, and even main highways are lined with drying *igusa*. This adds one more hazard to using the roads of the *igusa* producing sections of Japan. The drying *igusa* is turned two or three times each day so as to dry evenly. At night it is kept in the farmer's storehouse. About 70 per cent of the weight is lost while drying. Although the reed dries in two days, a week of rain at this time can mean a serious loss. Fortunately

FIG. 15. Rice is planted quickly after the *igusa* is cut, since the rice seedlings are already too far advanced. The rice harvest after *igusa* is less than if it follows wheat or barley. Dipping pool in foreground. Late July. Near Okayama City.

the Inland Sea region is usually dry during the harvest time.

MARKETING *Igusa*

After drying, the *igusa* is placed in a dry storehouse where it is protected from moisture, wind, and sun until the farmer has leisure to sort it. This is usually several weeks later as the farmer is very busy transplanting and caring for rice. Some of the farmers soon sell their crop to agents from factories in such weaving centers as Kurashiki and Seno. This may be done by the individual farmer or he may sell through the village co-operative. Other farmers, speculating on higher prices, retain their crop until later in the year. They may sell it gradually to meet current living expenses or for special expenses such as the *bon o dori* festival.

In less prosperous villages, part of the best *igusa* is retained and woven into mats within the home as a means of obtaining additional income. Although in a few homes power looms are owned, most looms are foot powered. The farmers and their families dislike home weaving with these manual powered looms. They complain about the poor pay, aching shoulders, stiff necks, and tired eyes. Today the better economic position of the farmers has resulted in a decline in home weaving. In Niiike, a village of 23 households, 17 operated looms in 1950 and only four in 1955. In the prosperous farming community of Kojo *son*, located on the better *shinden* lands, there is no home weaving. However, the introduction of more power looms might bring a revival of home weaving.

While the rushes are woven into mat coverings in homes or factories near where they are grown, the *tatami*

TABLE I

DOUBLE CROPPING OF RICE IN NIIIKE, 1954–1955

	Gross income per TAN[a]	*Expenses per* TAN	*Net income per* TAN
A. Wheat or barley followed by rice:			
Wheat or barley..	Yen[b] 7.500	1.000	6.500
Rice.....	24.000	1.500	22.500
Total.....	Yen 31.500	2.500	29.000
B. *Igusa* followed by rice:			
Igusa.....	Yen 50.000	3.500	46.500
Rice.....	14.400	0	14.400
Total.....	Yen 64.400	3.500	60.900

[a] One *tan* is .245 acres.
[b] In 1955 the official exchange rate was 360 yen to one United States dollar which was close to the free market rate.

omote is filled and sewed near the place of consumption.

COMPARATIVE POSITION OF *Igusa* IN DOUBLE CROPPING

Although *igusa* is a gross feeder requiring much more fertilizer than wheat, barley, or rice, and a rice crop following it does not give as high yields as after cereals, the high value of the *igusa* crop more than compensates. Two farming communities with wide variation in soils, topography, and farming practices illustrates the important position of *igusa* in the double cropping regime. The *aza* of Niiike is located in an area of older reclaimed back marshes, hills, and low mountains about 12 miles west of Okayama City while the *kumiai* of Dowa is located on the newer *shinden* lands in Kojo *son*, south of Okayama City. The location of Niiike and Dowa is shown in Figure 4.

These two communities were chosen for comparison because they both have about the same amount of land in *igusa* per household in spite of other variations. In both communities, a combination of rice and *igusa* brought about twice as much income for the same unit under cultivation as wheat or barley and rice as shown in Tables I and II. The yields were higher at Dowa, but the expenses were also higher so that the net income for *igusa* and rice per unit was about the same in both communities. In Niiike the fields were smaller and the farmers did not possess as much machinery. In 1955, only one of the 23 Niiike households possessed a motor cultivator while seven were used by the ten Dowa households. Less fertilizer and less hired labor were used in Niiike. The costs of irrigation were lower at Niiike as much of the irrigation there depends on gravity rather than pumping as at Dowa. No fertilizer is used on rice when it follows *igusa* in Niiike as the farmers claim the fields are already too heavily fertilized for rice.

Niiike's irrigated fields are located on an old reclaimed back marsh floodplain which has been farmed for over two thousand years. The wet paddy fields are surrounded by steep sloped hills and low mountains which are in forest or tree crops today.

In Niiike, *igusa* is next to rice as a source of income. In 1954, the net income from rice was estimated at 2,400,000 yen, from *igusa* at 1,000,000 yen, from employment outside the village at 820,000 yen, from wheat and barley at 390,000 yen, and from milk at 120,000 yen. The rice crop was less than normal because of damage from two typhoons.

In spite of the high profits from the cultivation of *igusa*, in 1955 only 16 per cent of the wet fields were planted in *igusa*. The Niiike farmers are afraid to risk too much of their land in it because of the speculative nature of the crop. Prices fluctuate considerably according to the general economic and political conditions of the country. After World War II, prices were high because of the extensive rebuilding but dropped during the Korean War as

TABLE II

DOUBLE CROPPING OF RICE IN DOWA, 1954–1955

	Gross income per TAN	*Expenses per* TAN	*Net income per* TAN
A. Wheat or barley followed by rice:			
Wheat or barley	Yen 12,000	2,000 Fertilizer	8,200
	..	1,000 Machinery Depreciation	..
	..	800 Hired Labor	..
		3,800	
Rice	Yen 30,000	1,200 Fertilizer	24,300
	..	1,000 Irrigation, Depreciation	..
	..	2,500 Hired Labor	..
	..	1,000 Insecticides	..
		5,700	
Total	Yen 42,000	9,500	32,500
B. *Igusa* followed by rice:			
Igusa	Yen 60,000	8,000 Fertilizer	43,000
	..	2,500 Irrigation, Depreciation	..
	..	5,000 Hired Labor	..
	..	1,500 Dipping Clay	..
		17,000	
Rice	Yen 24,000	300 Fertilizer	20,200
	..	1,000 Irrigation, Depreciation	..
	..	2,500 Hired Labor	..
	..	0 Insecticides	..
		3,800	
Total	Yen 84,000	20,800	63,200

there was fear of the war spreading and a possible repetition of destruction. The end of government controls did not bring a significant increase in planting because it was a time of uncertainty about the future.

Time is also an important factor because of the fact that during the *igusa* harvest the farmer has only a short time to cut, dip, and dry since each day lost reduces the rice crop. The biggest planter, the owner of Niiike's only motor cultivator, was able to plant about 30 per cent of his wet fields in *igusa* because the cultivator enabled him to replant the fields in rice more quickly than his neighbors who used draft animals. Hired farm labor has become so expensive in the post-war period that the Niiike farmers avoid it. Instead, each farmer takes the labor capacity of his family into consideration in planning the use of his land.

As already indicated, the increasing farm prosperity has resulted in a decline of home weaving of mats. In 1955, only four families were still weaving mat covers. Each produced on the average about 30 rolls of ten *tatami* length during the year. After deducting the cost of the hemp used in weaving, this added about 6000 yen to the value of the *igusa*.

The Dowa *kumiai* is located in Kojo *son* on land reclaimed about 75 years ago from part of Kojima Bay, an arm of the Inland Sea. The Dowa *kumiai*, one of a hundred *kumiai* in the *son* or township of Kojo, is composed of ten households and raises ten *tan* (2.45

acres) of *igusa*. Though the reclaimed soils of the former Kojima Bay are more fertile than those of Niiike, more fertilizer is applied. The result, as shown in Table II, is a higher production per *tan* although the expenses are greater.

While the farmers of Dowa normally use more hired labor than is the custom in Niiike, the family is still the basic unit. However, any further increase in production would necessitate complete reliance on hired labor for the additional work. The hired laborers come from the poorer farming areas in the Kibi plateau of Okayama Prefecture and from similar areas in the mountains of Kyushu across the Inland Sea. Since the war, an increasing rural prosperity affecting even the mountain areas has made fewer farmers willing to migrate for outside work. With fewer laborers available, their wages have risen sharply.

In Dowa as in the case of Niiike, the total profit from *igusa* followed by rice is double that of wheat or barley followed by rice. The farmers of both Dowa and Niiike gave the same reasons for not increasing the amount of land in *igusa*. Market fluctuations and uncertain weather conditions make profits uncertain and unpredictable. An increase in production would necessitate additional labor at high cost or the introduction of more machinery. The speculative nature of *igusa* production makes the farmer hesitate to expand his cultivation.

CONCLUSION

Igusa is important as a cash crop because it gives a higher cash return per unit under cultivation than rice, barley, or wheat and because it can be grown in the interval of time between the rice harvest and the planting of the subsequent rice crop. The increased income from *igusa* has brought rich results in better houses, a higher standard of living, and ability to experiment with mechanized farming equipment.

Igusa production is limited by topography, climate, and soils to certain favored areas of southern Japan. Its distribution within the areas of favorable physical conditions is further limited by the emphasis on rice cultivation, the experience of the farmers, and the speculative nature of the crop.

THE AGE STRUCTURE OF NEW ZEALAND'S NORTH ISLAND COMMUNITIES

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THE various forces which impinge upon and mould a society are reflected eventually in the age composition of the population. Thus, the pre-capitalist and the mature capitalist societies each display distinctive age structures, according to their different stages of development and different ways of life. Broad social and economic differences within a single state, such as appear between the European and the Maori in New Zealand, result in emphatically different age pyramids (Fig. 1). But differentiation by age structure is not limited to these broad national and international levels. The age composition faithfully reflects more subtle differences in ways of living; so that by their age structures it is possible to distinguish within New Zealand the sheep farming from the dairying community, the metropolitan from the borough community, and so forth. An analysis of the different age structures highlights some of the fundamental economic and social forces at work within the country.

The study of age structures transfers the attention of the geographer from the readily observable differences in the landscape to the less obvious social and economic foundations, and consequences, of those differences. In such a way he is also brought to grips with the demographic basis of human geography. And such an approach emphasizes the community as a unit of geographical study wherein the varied aspects of landscape and man's interaction with the habitat may be studied, rather than within the more formal divisions of regional, and frequently physical, boundaries.

This paper being largely of an exploratory nature, its scope, for convenience, has been limited to the North Island of New Zealand. But there is little doubt that what follows is in the main valid for the whole country, for more recent work on South Island communities and their age structures confirms the patterns which appear in the North Island. The development of the paper is simple. The contrasting age structures of the European and Maoris are described first, and then the urban and rural populations of both groups are discussed generally, after which the European community is analyzed by its constituent rural and urban communities.[1]

The New Zealand Census publishes rural age groupings for individual counties, but here individual counties have been grouped together regionally according to the predominant type of farming community; so that an age structure for

[1] Numbers and percentages have been computed principally from two volumes of the 1951 New Zealand Census of Population: Vol. II, "Ages and Marital Status"; and Vol. VI, "Maori Census." The type of divergence graph introduced by T. Lynn Smith has been preferred to age pyramids, both for purposes of analysis and illustration. See Smith, "Population Analysis," New York, 1948, pp. 102–105.

TABLE I

PERCENTAGE DISTRIBUTION OF POPULATION BY AGE

Age	*N. Z. Europeans 1952* percentage	*U.S.A. native white 1950* percentage	*Norway 1952* percentage	*Maori 1951* percentage	*Western Samoa 1951* percentage
0–5	11.5	11.4	9.2	18.7	18.2
5–15	17.8	17.1	15.8	27.8	28.8
15–25	13.3	15.4	12.7	19.8	18.6
25–65	47.9	49.1	52.6	31.2	31.9
65 and over	9.5	7.0	9.8	2.4	2.4
	100	100	100	100	100

Taranaki dairying community, or Wairarapa sheep farming community is obtained (see Fig. 5). Likewise, the populations of all North Island boroughs have been added together, as have the populations of all the provincial cities, and from the total figures the age structures of these two urban communities have been derived. Such a process is quite justified because individual boroughs and provincial cities display such marked similarities in functions, forms, and development, that one may speak, for example, of the borough community as a general urban type. This is not to deny that there are variations between settlements of the same type, but at the present level of generalization this can be safely ignored.

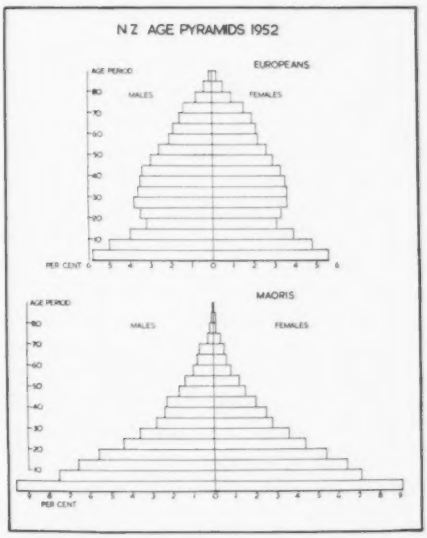

FIG. 1.

AGE STRUCTURE OF THE MAORIS

Though assimilation is slowly taking place, and the Maori community can in theory freely participate in New Zealand society, that community remains distinct from the European group. How distinct, is suggested by the age pyramids of the two peoples (Fig. 1). Whereas the European age structure is similar to those of Australia, North America, and northwest Europe, the Maori age structure is very like the Fijian or Samoan age structures, displaying a huge potential for growth (Table I). Nevertheless, the Maoris represent only a small proportion of the total population, and, while that proportion may increase (it is estimated to increase to something between 8.2 per cent and 9.3 per cent of the total population by 1972), it will never be large, or prejudice the European numerical superiority.[2]

The characteristics and history of the Maori population are typical of a non-western cultural group subjected to European influences. During the first

[2] Supplement to *Monthly Abstract of Statistics*, December, 1953, Census and Statistics, Wellington, New Zealand, Government Printer.

TABLE II

AGE STRUCTURES OF URBAN MAORIS, 1951

Age	*Total Maoris* *percentage* *A*		*Urban Maoris* *percentage* *B*		*N. Z. Urban* *percentage* *C*		*Maoris female* *percentage of total Maori population* *D*		*Urban Maori females* *percentage of total Maori urban population* *E*	
0–15	46½		35		26½		22½		18	
15–25	20	42	27	53	14	42	10	21	16	29
25–35	13		15½		14		6½		8	
35–45	9		10½		14		4½		5	
45–55	6		6		11		2½		3	

phases of contact the population declined, reaching its lowest level of about 42,000 in 1896, since when it has increased to 115,500 in 1951. Still mainly rural,[3] with a low but not desperately low standard of living and a high birth rate, the population displays a high potential for growth. The Maoris are prone to certain epidemic and infectious diseases which, combined with an infant mortality rate three times that of the whites, have kept the death rate high; but it is declining. Casualties of the last war have influenced the age structure but slightly, and immigration plays no part. As the process of acculturation continues and economic standards improve, the death rate can be expected to decline still further. The birth rate may change with higher living standards or urbanization, but it is the falling death rate that will probably be the most significant factor influencing growth during the next 20 years. Because the Maoris are a highly localized community, found especially in Northland, East Cape, South Auckland, and Central Plateau, the problems associated with their growth are confined particularly to these and adjacent areas. At the moment there is a great demand for school buildings and other educational requirements; within a few years the problem of an increased labor force and its employment will arise. Maori land development is taking place in these areas, though it can never cater for more than a small percentage of the growth. Industry may be redistributed to these areas; or the urban drift will increase, demanding thought and care on the part of administrators.

[3] Maori Population, 1951. Eighty-one per cent rural, Maoris comprise 6 per cent of the total New Zealand population, 13 per cent of the total New Zealand rural population, 19 per cent of the North Island rural population.

MAORIS, RURAL AND URBAN

Since the Maoris are a predominantly rural community the age structure for the rural Maoris is not very different from the total Maori age structure; thus the rural age structure is heavily weighted towards the youngest age groups. The Maori urban age structure, when compared with the total Maori age structures (Table II, A and B), reveals that urbanization is taking place amongst the young Maoris, and that the females especially are being attracted towards the towns (Table II, D and E). There is a relative deficit of children and old amongst the Maori urban population. When compared with the New Zealand urban structure the Maori urban population is much younger and has a greater percentage of children than the Europeans, a reflection of the large proportions of urban Maoris in the young reproductive age groups (Table II, B and C). In addition, it is

highly probable that the Maori urban birth rate exceeds the European one; urbanization, as yet, has not put an end to the cultural differences.

AGE STRUCTURE OF THE EUROPEANS

The European age pyramid has been sculptured by a number of factors, often the same ones that have affected other Western countries. The pyramid's wide base, and the decided nick above, both result from variations in the birth rate over the past three decades (Fig. 1). New Zealand suffered the declining birth rates of the interwar years, and has enjoyed the postwar rise in the birth rate. Higher up the pyramid are reflected the increased birth rate that occurred after World War I, and, above, the inevitable low birth rate of that war period, plus the casualties suffered during World War II. Longer life expectancy has influenced the uppermost part of the pyramid, and the greater life expectation of the females has determined the high femininity of these older populations. Immigration tends to increase the labor force and emphasize the masculinity of the working age groups.

Those past and recent variations in the birth rate are a source of present-day concern, for they have influenced the size of the future labor force, and the numbers and proportions of dependents. While the percentage in the 0–15 age groups was approximately the same in 1926 as in 1951, 30 per cent, the percentage of over 60 had increased: 7.8 per cent, 1926 to 13.2 per cent, 1951; and the percentage in the 15–60 group, from which the labor force is drawn, had fallen from 62 per cent, 1926 to 57 per cent, 1951; and there is little likelihood of this percentage increasing over the next 20 years.[4]

[4] Economic Survey, 1953, Government Printer, Wellington.

EUROPEANS, RURAL AND URBAN

We might suppose that the age structure of any particular community, say the New Zealand rural community, is exactly the same as the national age structure; that the proportion of people in each age group is exactly the same for the rural community and the nation as a whole. Expressed as age pyramids, the shapes would then be exactly the same. In fact there are marked differences between the rural and the national age structures; this could be illustrated by placing an age pyramid for the rural community over an age pyramid for the whole nation. The divergences would be apparent; though they would be difficult to judge by eye. However, if the proportion in the national 0–5 age group is represented as 100; and the proportion in the rural 0–5 age group is expressed as an index number of the national proportion, and so on for each age group; then the divergence of the rural age structure from the national age structure can be expressed, if a little exaggeratedly, by the method used in Figures 2, 3, and 4. Here the 100 line represents the national age structure; where the curve for the particular community lies above the line it means that there is a relative excess of population for those age groups. Where it lies below the 100 line it means there is a relative deficit for those age groups. In Figure 2, B, the curve for the European rural population lies above the 100 line for the younger age groups; this is merely expressing visually that whereas 32.4 per cent of the rural population is between 0 and 15 years, only 29.3 per cent of the total New Zealand population is between 0 and 15 years. Thus in the rural areas there is a relative excess of persons in these age groups. Similarly, although the number over 65 is only

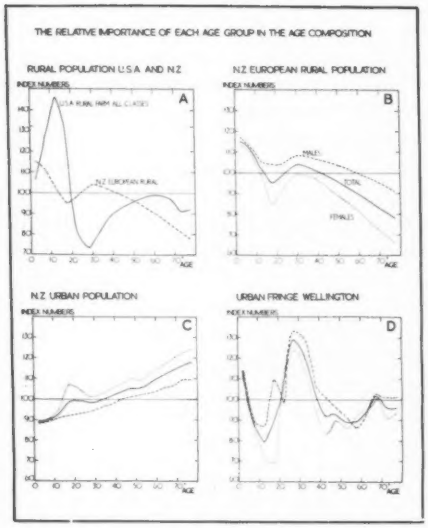

FIG. 2.

7.5 per cent of the rural population, 9.2 per cent of the New Zealand total population is above that age. In Figure 2, B, the curve lies well below the national age structure, the 100 line, representing a relative deficit. Comparing B and C, Figure 2, one may say that the rural community is a younger population than the urban community, since the former's excess occurs among the younger age groups, whereas the urban excess occurs in the older age groups.[5]

As with most Western countries, the New Zealand rural community has a relative excess of children, while the urban population has a relative deficit. The working age population in the rural areas tends also to be younger than in the towns. Whereas the rural community displays a marked deficit in the older age groups the urban community has a marked excess. Thus the rural community derives its character from its children and younger working age groups, and the urban community is characterized by its working age groups and its older people.

When the age composition by sex for both communities is considered, further significant points arise (Fig. 2, B and C). The rural community has a greater proportion of males to females than the urban. From 15–30 years of age there is a marked migration of females away from the rural areas (signified by the drop in the curve for females—Fig. 2, B); this migration shows up as a relative excess of females for the same ages in urban areas (note the rise in the curve for females at 15 years Fig. 2, C). This excess is in fact maintained in the urban areas from 15 years and onwards. During the early years of marriage, the late twenties and early thirties, the rural areas have almost a normal proportion of females (note Fig. 2, B, how the female curve approaches the 100 line at these ages), but after the late thirties there is a relative deficit of females. The rural areas, however, display a surplus of males until about 55 years, and the urban areas display a relative deficit of males until the same age; afterwards the positions are reversed. A variety of factors, the attitudes of females toward rural life, employment opportunities for females, the prosperity of New Zealand farming, and the nature of urban as against rural male occupations, all combine to explain these differences of age composition by sex.

In one particular respect the New Zealand rural community appears to be a fortunate one. Unlike the rural farm population of the United States, the New Zealand rural community retains a little more than its fair share of the younger working age group 25–40 years; i.e., it has a relative excess,

[5] In percentages, for example, 0–15 years, rural, 32.4 per cent, urban, 26.5 per cent; 65 and over, rural, 7.5 per cent, urban, 10.5 per cent. For percentage figures and further tabulation see Table III.

whereas the American rural farm population has a relative deficit in this age group resulting from migration to urban areas. (Note in Fig. 2, A, the New Zealand curve is above the 100 index for these ages, revealing it has more than a proportional share; the United States curve lies well below.) In other words, the burden of dependents, children and the old, is relatively greater in American rural areas than in New Zealand. Australia appears to be as favored as New Zealand in this respect, while the Canadian and South African rural communities suffer under the same disadvantages as the American. It must be of importance to New Zealand farming that its working community is weighted towards youth and vigor, rather than age and conservatism. Undoubtedly the high per capita productivity of New Zealand farming and the comparatively small differences between rural and urban living standards go a long way towards explaining this favorable age structure.[6]

URBAN COMMUNITIES OF THE NORTH ISLAND

The New Zealand town functions principally as a market town, or, better, a trading center, for it resembles the American town rather than the English one. There are exceptions to this generalization, and settlements which are mainly industrial or mining communities, or tourist centers are to be found. However, the towns of the Dominion are primarily concerned with servicing the surrounding rural communities, collecting and dispatching their products, and distributing goods to them, and so they are important transport, as well as trading, centers. In addition, they act as administrative and social centers. Often their industrial activities are closely related to the needs or products of the countryside, but increasingly in some of the larger centers, about 20,000 and over, industries not immediately connected with rural life, such as textiles and footwear, are being developed, in which females are finding employment. As the sizes of towns increase, their activities and interests become more remote from rural life and they gain a life of their own and individuality of character. This is especially so in the metropolitan centers. But basically they are all transport and trading centers.

The settlements with populations of 1000–2500, boroughs, are the purest examples of trading centers and their relationships with the rural community the most obvious. (The range could have been extended to 3000 but the difference involved in the results is negligible.) These settlements are the veritable "Main Street" of New Zealand, and they are comparable with "Main Street," America, in form, function, historical development, appearance, and in the outlook and philosophy of their inhabitants. The second group of settlements chosen for analysis are the provincial cities, 20,000–35,000. These act as regional centers and have a few services or facilities not to be found in the smaller trading centers. Many are small ports and most have some industries—metal working, engineering and assembly, printing and publishing, textiles and footwear, food processing. There are some 20 settlements with populations between 3 and 20 thousand, but for the present they have been ignored. The four main centers, of which Auckland and Wellington are in the North Island, while still concerned

[6] In Figure 2, A, the age structure of the United States Rural Farm population has, of course, been expressed in relation to the United States total population age structure; and the New Zealand rural population age structure expressed in relation to the New Zealand total population age structure.

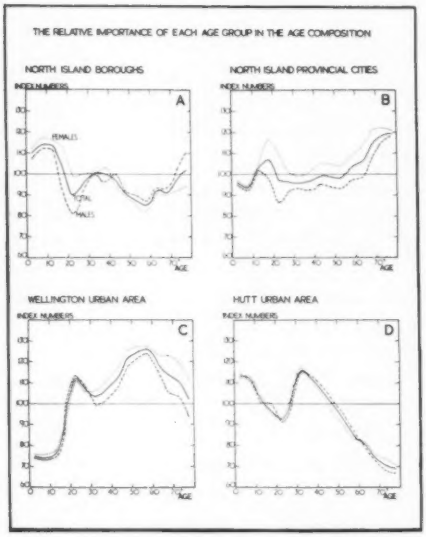

FIG. 3.

with servicing the rural community, do so on a larger and more remote scale. They are the principal exits and entrances for goods; they act as main commercial, educational, and cultural centers; they are important industrial cities; and Wellington is the administrative center for the country as a whole. They represent the most urbanized communities of the Dominion, and their way of life resembles that of other larger cities in the western world. Adjacent to both of them lies the rural-urban, or suburban community, composed of dormitory or commuter settlements, plus the usual conglomeration of a fringe area: market gardeners, city milk suppliers, and retired people living in beach settlements. These areas gain their character from the intermixture of rural and urban life, but principally from the fact that they are areas of recent residential development and thus possess distinctive age structures.

BOROUGHS AND PROVINCIAL CITIES

The age structure of the boroughs tends to resemble that of the European rural community rather than of the urban community for it displays an excess of children, and its working population tends to be young (Fig. 3, A, and Table III). However, it differs from that of the rural community in a number of important respects. The boroughs are used as places of retirement, and are favored by the males. Females make up a larger percentage of the total population than in rural areas. The migration of males is more marked than that of the females between the ages of 15 and 30; this is the opposite to what happens in the rural community (c.f. Figs. 3, A, and 2, B). Some of the males presumably move out to the rural districts, but the majority move to the larger centers. Although some of the

TABLE III

AGE STRUCTURES OF NORTH ISLAND URBAN COMMUNITIES, 1951

Age Group	*Percentages*																	
	N. Z. urban		*European rural*		*Boroughs (North Island)*		*Provincial cities (North Island)*		*Wellington urban area*		*Auckland city*		*Hutt urban area*		*Total N. Z. population*		*Total European pop. 1952*	
	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.
0–15	13.4	13.1	16.7	15.7	16.4	16.6	14.4	14.0	11.0	10.8	10.8	10.8	16.3	15.9	14.9	14.4	14.9	14.3
15–25	6.6	7.3	7.5	5.9	6.2	7.2	6.6	7.7	7.2	7.2	6.8	7.1	6.7	6.4	7.2	6.8	6.8	6.4
25–45	13.8	14.6	15.3	13.7	13.8	14.1	13.2	14.2	14.8	15.5	14.2	15.0	15.6	15.5	14.2	14.1	14.3	14.1
45–65	9.7	10.9	9.6	8.1	8.6	8.4	9.0	10.3	11.3	12.1	11.4	12.2	8.7	8.5	9.5	9.6	9.7	9.9
65 and over	4.7	5.8	4.1	3.4	4.4	4.4	4.9	5.8	4.4	5.7	5.3	6.4	3.0	3.5	4.4	4.8	4.5	5.0

females also move to the larger urban areas, a number find employment in the shops and services of the boroughs.

The age structure of the provincial cities shows less variation from the national structure than does that of the other urban communities (Table III and Fig. 3, B). (Note the tendency of the total curve to parallel closely the 100 line between the ages of 25 and 60.) However, in contrast to the boroughs, the provincial cities have a small deficit of young children; although for the ages 10–15 they reveal a relative excess, which may be related to the location of secondary boarding schools in these cities. From about 15 years onwards the provincial cities display an excess of females, marked between the ages of 15 to 25 and, in part, related to the development of manufacturing industries in these cities (in Fig. 3, B, this is shown by a marked rise in the curve for females for these ages). The slight male deficit remains from 15 years to about 60 years, when an excess appears. These cities are important centers for retirement for both males and females; note the rising curves for the older age groups (Fig. 3, B).

THE MAIN CENTERS

The age structures of the North Island's largest urban communities are illustrated by the examples of Wellington Urban Area and Hutt Urban Area.[7] Situated on the shores of Port Nicholson Harbour the two settlements, because of the harbor's configuration, are separated by some five miles. Although they are closely related, both economically and socially (there is a daily exchange of workers, and Wellington is an important shopping, business, and entertainment center for the Hutt), they have somewhat different histories and functions, in part arising out of their physical separation. Wellington, the port, though not unimportant for its manufacturing, is outstanding for its tertiary industries. In 1951, they accounted for 66 per cent of the city's total occupied labor force. In contrast, the Hutt Urban Area having plenty of flat land has been developed, especially since the nineteen thirties, as an industrial area. Only 49 per cent of its labor force was engaged in tertiary industry. The age structures of the two areas display these historical and economic differences (Fig. 3, C and D).

Wellington's population is essentially of working age, 68 per cent of its total being between the ages of 15 and 65; compared with the New Zealand urban proportion of 63 per cent. Naturally, the proportion of children is relatively low. As in the provincial cities, females above the age of 15 years are attracted to Wellington, and a notable excess of females persists from 20 years and onwards. A particularly distinguishing feature of the city's population is the appearance of a relative surplus of males at 20 years, representing a migration inward to find work in factories, or to receive training in a profession or some tertiary occupation. Inevitably, some move away to the provincial branches of firms or establishments or set up a family in the suburbs outside the main city area. This is represented by the downward movement of the curves for the ages 25–35 (Fig. 3, C). Between the ages of 35 and 65 years, however, a notable male excess occurs. The retired age group, particularly amongst the females, is important.[8]

[7] An urban area is a statistical device of the Census, lumping together the contiguous built-up areas which are effectively and economically linked, in an attempt to overcome the anachronisms of local body history and growth.

[8] Auckland City has an age structure very similar to that of the Wellington Urban Area, and for very much the same reasons (Table III). The difference between Wellington Urban Area

(*Continued on next page*)

TABLE IV

AGE STRUCTURES OF THE URBAN FRINGE AREAS, 1951

Age group	*Wellington fringe* percentage		*Auckland fringe* percentage		*N. Z. total* percentage		*N. Z. urban* percentage	
	M.	*F.*	*M.*	*F.*	*M.*	*F.*	*M.*	*F.*
0–5	6.9	6.8	6.8	6.5	6.1	5.9	5.4	5.3
5–10	4.2	4.0	4.9	4.6	4.8	4.6	4.3	4.1
20–35	13.3	12.8	11.9	11.4	11.0	10.9	10.4	11.1
65 and over	4.4	4.6	4.8	4.0	4.4	4.8	4.7	5.8

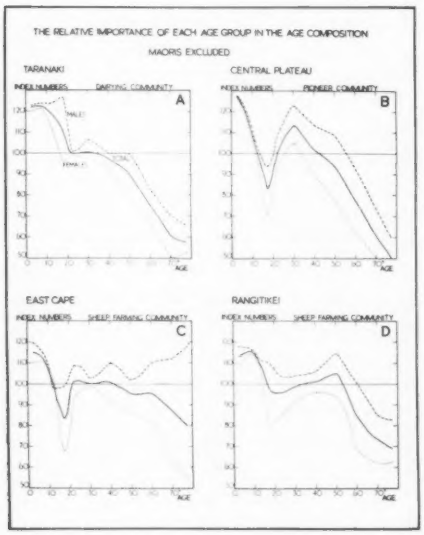

FIG. 4.

The Hutt age structure is very different (Fig. 3, D, and Table III). At first glance it is not unlike the structure of the pioneer rural areas described later (Fig. 4, B). The resemblance arises because both have recently expanded in population, and the pattern is one of working-age parents and their young families; the over-fifties are noticeably absent. Being an urban area, however, and made up largely of married people and their families, the sex ratio throughout the age groups is more balanced than that of the pioneer districts (on Table VI contrast Hutt with the Central Plateau). The Hutt has an excess of children under 15 years, a slight deficit of both males and females between 15 and 25 years, an excess from 25–45 years, and an increasing deficit thereafter, in all cases of both males and females. With time and development the age structure of the Hutt should conform more closely to that of the Wellington Urban Area.

THE URBAN FRINGE

About the fringes of Wellington and Auckland lie the recently developed (post-war in many cases) dormitory areas, intermixed with farm land, beach settlements, isolation hospitals, schools, military establishments, public works camps, and immigrant transit camps. Within the Wellington fringe there is only a small farming community, and consequently the age structure of the commuter areas is clear (Fig. 2, D). The Auckland fringe includes a large proportion of farm people which tends to modify the structure. Nevertheless, the age structures of the two areas resemble one another and are distinct

(pop. 133,400) and Wellington City (pop. 120,000) is negligible, whereas the difference between the Auckland Urban Area (pop. 329,100) and Auckland City (pop. 127,400) is not. The Auckland Urban Area contains such a variety of settlements in so many stages of development that the age structure of the densely settled compact and central part, in effect Auckland City, is obscured by the inclusion of figures for new suburbs, dormitory area, and the fringe zone. Consequently, although the Auckland Urban Area is the largest urban group in the Dominion, it is not the best example for displaying the age structure of the main cities.

from the other urban or rural structures (Table IV). Three main groups are represented. The newlyweds, 20–35, and their children, mostly under 5, make up the bulk of the population; the retired group over 60 or 65 years is the third group, which seems to be attracted to the beach settlements. On the whole the sexes are fairly balanced throughout the age groups, though the areas have a slight masculinity arising because of the public works and immigrant camps, etc., which house mainly men.

The contrasts which appear between the rural and urban age structures, and the age structures of the different urban communities are a response to varying physical and economic conditions, occupational opportunities, attitudes, and value systems. It is generally conceded that a lower birth rate is related to urban life, a fact reflected in the relative deficit of children in the urban age structure. This pattern holds for New Zealand, except in the case of the boroughs, where a surplus of children exists. No explanation of this fact can be offered, except to suggest that the social values and practices which influence the higher birth rate of rural areas have some influence on these settlements so closely related to country life. The economic opportunities which females are offered in secondary and tertiary industries, together with the attractions of city life, do much to explain the female surpluses in urban areas, especially the marked surpluses in the main centers. The greater maturity of the urban male group in comparison with the rural male group may be explained, partly, by the suitability of urban occupations for older men. The demand for sheer physical energy which exists in rural occupations is not so marked in the urban industries, which employ many males as clerks or salesmen, and which offer many executive and administrative posts where age is an advantage. Thus the nature of urban employment is a major factor explaining the more mature age structure of the cities and towns. Furthermore, only in Wellington and Auckland does a male excess appear between 20 and 25 years, a feature related to the size of these cities, which allows certain specialized types of employment or training, unobtainable in the smaller centers, to be offered; e.g., university education or training of junior executives at head offices.

An opinion held widely in New Zealand is that the farming community regard farming as an economic proposition rather than vocation or way of life, and, therefore, the tendency is to make money and retire, or move out as quickly as possible. How correct is this opinion cannot be said, but rural people do leave the country in their later years to retire and settle in the towns. This lends the urban age structure one of its most characteristic features, and the apparent preferences for different types and sizes of urban settlement leads to variations within the urban age structures. In all, the greater degree of specialization, the elaboration of functions, and the greater variety of social life, which are associated with increases in size of urban settlements, explain the contrasting age structures of the urban communities.

RURAL COMMUNITIES OF THE NORTH ISLAND

The principal features of the rural community as a whole have already been discussed; namely, that its population is weighted towards children and the younger working age groups, and that in comparison with those of some other Western countries the farming community is fortunate in retaining its share of the vigorous productive age groups. Three major rural communities

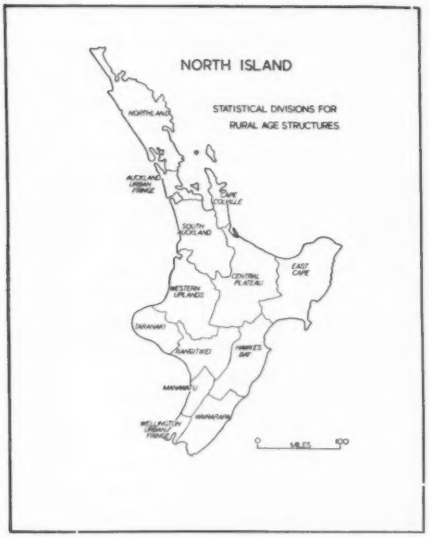

FIG. 5.

are located in the North Island. Two of them, the dairying and the sheep farming communities, can be differentiated according to their mode of land utilization and habitat, economic organization, daily and seasonal round of work, settlement patterns, regional affiliations, and degrees of isolation and accessibility. The third major community is made up of those people engaged in developing areas of the North Island which have presented strong physical and economic barriers to successful and permanent settlement. They are twentieth century pioneers requiring Government assistance and favorable economic conditions to aid their establishment.

Each of the three major rural communities is made up of a number of communities pursuing the same way of life, but very often located in separate regions; and, frequently, with histories similar in general outline but differing considerably in detail. Thus the dairying community is located principally in two regions, South Auckland and Taranaki (Fig. 5). But, despite this, and despite the fact that South Auckland developed somewhat later than Taranaki, their individual age structures are so alike, and so distinct from the others, as to permit one to speak generally of the dairying community's age structure (Table V). The Central Plateau and the Western Uplands are areas of pioneer development, and in a similar fashion, and for the same reasons, one can speak of the pioneer community's age structure. It is the same for the sheep farming community, which is made up of five separate regions and individual communities: Rangitikei, Wairarapa, East Cape, Hawkes Bay, and Manawatu. Figure 4 illustrates these contrasting age structures for representative communities and in Table V the age structures for each of the individual regions and communities, grouped according to the major community type, are set out.[9]

A glance along the columns of Table V is sufficient to bring out the principal contrasts between the major communities. In the pioneer and dairying communities the percentages for the 0–15 age group are higher than those for the sheep farming communities, whereas these latter communities have a greater percentage in the 45–65 and over 65 age groups than the pioneer and dairying communities. The same facts are illustrated in Figure 4 where the relative surplus of children, and the relative deficit in the older age groups, is greater in the pioneer and dairying communities than in the sheep farming community. Generally, then, the sheep farming community is a somewhat older community than the other two. The con-

[9] In addition in Table V sample South Island sheep farming community age structures are included to illustrate the point that, despite differing locations and somewhat different histories, similar ways of life and economic organization produce similar age structures.

TABLE V

EUROPEAN RURAL AGE STRUCTURES

Age group	*Percentages*												
	Pioneer community			*Dairying community*		*North Island Sheep farming community*					*South Island Sheep farming community*		
	N. Z. European rural	*Central Plateau*	*Western Uplands*	*South Auckland*	*Taranaki*	*Rangitikei*	*Wairarapa*	*East Cape*	*Hawkes Bay*	*Manawatu*	*Kaikoura*	*Central Otago*	*Southland*
0–15	32.3	34.5	34.4	34.7	35.6	33.3	33.5	32.4	32.0	31.9	31.8	30.2	33.2
15–20	6.4	5.6	5.6	6.6	7.6	6.4	6.1	5.6	6.4	7.3	6.3	6.0	6.5
20–45	36.1	38.2	39.1	36.6	35.4	35.3	36.3	36.0	35.2	34.2	36.0	38.1	36.3
45–65	17.7	16.5	15.5	16.5	15.9	18.3	17.8	18.1	18.9	18.7	18.2	18.1	16.8
65 and over	7.5	5.2	5.4	5.6	5.5	6.7	6.3	7.9	7.5	8.0	7.7	7.5	7.2

trasts, however, do not end here, for when the age and sex composition are considered, further differences arise.

While both the pioneer and dairying communities are young populations, the pioneer community has a greater concentration of men in the younger working age group and has generally a lower proportion of females to males (sex ratio) than the dairying community. Thus while Taranaki (dairying) recorded 18.5 per cent of its population in the male 20–45 age group, the Central Plateau's figure was 21 per cent; for the other pioneer area, the Western Uplands, the figure reached was 22.75 per cent. Further, contrast the heaping up of the male curve for these ages in the Central Plateau with that for Taranaki (Fig. 4, A and B). Table VI illustrates the sex ratios by age for Taranaki and Central Plateau, from which the greater masculinity of the pioneer area's population is evident. The sex ratios for the sheep farming areas are lower than for the dairying, but higher than for the pioneer areas. Note also the male population is older than in the pioneer or dairying communities (Fig. 4).

The age structure of the pioneer community arises out of the need for the young and energetic in such areas; and the high masculinity of the population is explicable in terms of the demand for labor in the forest industries, and in the power development schemes, the breaking in of the land, and the development of farming. Both pioneer areas, Central Plateau and Western Uplands, have offered difficulties to successful farming which are now being overcome; accessibility is improving, and in the Central Plateau development of timber and power resources is rapidly changing the geography of the region. Eventually, this region will become important also as a dairying area, and consequently its rural population should tend to assume a structure similar to those of the other dairying areas. Already there are affinities. The pioneer characteristics of the Western Uplands will probably remain longer. A sheep rearing area, it is beset with problems of land use and accessibility, but nevertheless it has some potential for development. Over the years its rural population will most likely assume the structure of that of other sheep raising areas.

To explain the clearly marked tendency for the population of the sheep farming community to be older than the dairying group, attention must be directed towards the contrasting scales

TABLE VI

SEX RATIOS BY AGE GROUPS FOR EUROPEAN POPULATION, 1951

Females per 100 males

Age group	*N. Z. total population*	*Taranaki*	*East Cape*	*Central Plateau*	*Boroughs 1000–2500*	*Hutt urban*	*Wellington urban*
0–5	96	94	88	97	101	95	98
5–10	96	94	93	94	100	98	99
10–15	97	89	100	93	100	100	99
15–20	95	72	66	72	118	95	107
20–25	96	93	81	81	117	97	93
25–35	100	91	96	87	106	103	91
35–45	98	91	82	78	100	94	107
45–55	97	77	81	69	92	92	103
55–65	107	88	80	71	103	107	112
65–75	107	77	60	70	100	111	125
75 and over	117	95	52	66	99	125	141
Overall sex ratio	99	88	84	82	103	99	105

of operation and organization within the two industries, the ease with which the new farmer may enter each activity, and the influence of the female population of these areas. The dairy and the sheep industries are markedly different forms of organization with differing labor requirements. Dairy farming is an exacting seven-day-a-week living, requiring early rising and late working. It tends to lack the seasonal variations in activities of the sheep farm and calls for sustained effort. Although the sheep farmer-owner often participates in the heavy work himself, nevertheless much of the heavy work—shearing, ploughing, scrub cutting, and sometimes fencing—is done by outside contractors. And whereas at 50 years or so the sheep farm-owner, depending on the type and size of farm, can, if he wishes, concern himself more with the purely managerial side of the farm, participating less in the heavier work, extra labor, contract or hired, is generally uneconomical to the dairy farmer with his much smaller unit. He, himself, must always be the principal source of labor. Working at different scales of organization the dairy industry, because its managerial and laboring functions are combined in one man, demands a somewhat younger labor force. In the sheep industry these functions are divided among a number of persons and at certain scales it becomes economical to have one man devoting himself largely to management.

Related to these points are two additional facts. On the whole it is financially easier for a young man to enter agriculture as a dairy farmer. In 1952 prices ruling for dairy units on land of average quality exclusive of stock and farm equipment ranged from £NZ5000 to £NZ8000. Those for sheep farms were much higher. Some of the younger men commence their farming careers as share milkers on large dairy units, receiving 40 per cent or more of the gross returns for their labors and whatever else they contribute.[10] The aging dairy farmer can lessen his burden by taking on a share milker, but the status is satisfactory only to a young man. By 1952 the Government had assisted some 10,600 ex-servicemen to become farmers. They were a young age group and mostly engaged in dairy farming.[11]

Finally, dairying areas have a higher sex ratio than sheep farming areas, and because the rural female population as a whole is a young one, the greater

[10] "Primary Production in New Zealand," Department of Agriculture, Wellington, New Zealand, 1952.

[11] New Zealand Official Year Book 1953, Government Printer, Wellington, New Zealand.

proportion of females in the dairying group would tend to give it a slightly younger age structure. It may be true that children are more of an economic asset on a dairying farm than a sheep station, being more easily incorporated into the daily round of milking, cleaning, carrying, and fetching. But it would be difficult to prove that this influences the age structures. It must be stressed that all these points are brought forward to explain the divergence in age structures between the two communities, and even if the explanations are valid it does not follow that all dairy farmers are younger than sheep farmers.

The age structures for two North Island regions, Northland and Cape Colville, do not fit into any of the three major communities designated. Like the dairying areas the proportion of Northland's population under 15 years is high, 34.8 per cent, but the proportions for 45–65 years and over 65 years are higher than those of the dairying areas and, furthermore, Northland's population is more masculine. Even when some of the northern counties are excluded and one focuses on the more developed southern group, Northland's structure is not altered significantly. The final explanation of this unconformity cannot be given; further inquiries, principally historical, are necessary. However, there are three possible explanations which are not mutually exclusive. The most probable is that with the growth of dairying in the Northland area during the past 30 years the age structure is undergoing a change and slowly conforming to the pattern of other dairying communities. Secondly, it is possible that non-farm people in numerous village communities, who are classed nevertheless as rural persons, are affecting the age structure both in Northland and Cape Colville. Finally, of less importance in Northland, but of more significance in Cape Colville, the physical diversity of the area results in a mixing areally of the sheep and dairy farmers so that viewed statistically neither one may be seen separately. Thus, in Cape Colville sheep farming is of considerably more importance in Coromandel County than in the other two counties making up the region; and in Northland Rodney County, which includes approximately 9 per cent of Northland's population, provides the one example where sheep farming is of notable importance. Whatever the final explanation, these two exceptions do not alter the main conclusions of the differing age structures of the major rural communities.

CONCLUSION

It seems worthwhile, by way of a conclusion, to review in a more general manner the question, why do age structures vary within New Zealand? To recall the reasons for different countries having different age structures is a useful first step towards appreciating the general circumstances which influence markedly the New Zealand variations.

Geographers for some time have implicitly recognized that the age pyramid, or structure, is one of the most accessible and illuminating indices to the social and economic life of a community. The contrasting age structures of, say, India and New Zealand are a crude but recent summary of what has happened in these particular societies; implying two fundamentally different ways of life and methods of economic organization. To obtain an age structure like New Zealand's, a considerable number of necessary conditions are required. Thus the swelling of the upper part of the pyramid is dependent upon a low death rate, which again is dependent upon a cultural background of

scientific investigation applied to medicine, supported by the technological achievements of drugs and good sanitation, and the institutional achievements of effective medical administration and thorough national and local body government. That females constitute a large proportion of the older age groups is a result of greater female life expectancy; in its turn this is dependent on the social values placed upon females. A country's age structure then is dependent on the culture and technology of its society; and if major variations between countries are to be explained in this manner, it is likely that any variations in age structures that appear within a country are rooted in the culture and technology of the society. In fact, the cultural circumstances of the post industrial revolution period seem necessary conditions for such internal variations.

In a sense the population of New Zealand may be divided into two groups, the first, the male population between 15–65, the second, the remainder. The location of this male population group is dependent upon the location of economic activity and opportunity within the country; and the two distributions are unlikely to show any marked divergence. The female group 15–65 is not so dependent on either the distribution of economic activity or the males. In the first place, social customs permit them to engage only in certain specified industries, principally tertiary and some selected secondary industries; very few find employment, as such, in primary industries. The locational pattern of these selected secondary and tertiary industries is not exactly that of the overall economic pattern, or of the male pattern of employment. Consequently, the fact that the society permits the female to take up a livelihood other than marriage, and prefers certain activities to others, leads to local variations in distribution of males and females and therefore in the age structures. Of course, the large proportion of females marry and consequently their distribution tends to conform with that of the male. But, as we have seen, the conformation is by no means exact. No female and especially no male need feel any sense of compunction if remaining single; and, particularly, any female who remains, or is forced to remain, single can find a livelihood in the towns. The social values of a section of the females are such that the disadvantages of country life, and life in the pioneering areas, seems to outweigh any advantages, and thus a number of females must prefer spinsterhood, and possible loneliness, to a hardier but married existence. Because of the comparatively late date of marriage and because females are encouraged to take some form of training, whether it be education or typing, differential movements of males and females are set up between the ages of 15 and 25, which again influence the variations of age structure. Principally they make for contrasts between the rural and urban areas.

The proportion of children may be considered as a variable, this time related to the location of the male and female population. The disparity in numbers of males and females in towns, combined with the social factors arising out of urbanization which make for a low birth rate, results in a smaller proportion of children in the large urban areas. The disparity of male and female numbers in rural areas is overcome, partly, by the social factors which make for a higher birth rate and the higher degree of marriage amongst rural females, so that the proportion of children is higher. Thus are further contrasts in age structure produced.

It will have been noticed that major variations in age structure in New

Zealand have been largely in terms of variations in the proportion of children and the proportion of retired people. The over-sixty group constitutes one of the most important variables in New Zealand age structures. The existence of this group is largely dependent upon the technological and institutional achievements of the industrial revolution era, and also the productivity of a society which permits the accumulation of capital and the provision of pensions from which this section supports itself. Thus, of all groups the distribution of the retired group is least affected by the distribution of economic activities; it is, in a sense, therefore, a highly mobile group leading to variations in the age structure. Furthermore, our conception of filial duties and the family group means that instead of being tied to its mature children as would happen in a more backward economy this section of the population moves about, leading to the formation of specifically retirement areas. Viewed in this manner it will be seen that the different structures of New Zealand communities are neither absolutely inevitable or necessarily permanent, though they are likely to remain for some time. Changes in a number of factors are likely to produce alterations; e.g., a further aging of the population, improved accessibility to rural areas making the life more encouraging to the female, redistribution of secondary industry.

This study has focused attention on the use of age structures as a tool for the social and economic interpretation of communities and it has stressed communities rather than regions. An attempt has been made to look beyond the formal lines of regional divisions to the community, the real unit in which the human and physical materials of the geographer are in fact integrated. Thus, the nature of urban life is not only to be seen geographically in form and function, but in the characteristics of the people, and age structures and sex ratios are as important indices of urbanness as are density of settlement or street patterns. In rural life the study has illustrated that differentiation between sheep and dairy farming areas may go beyond land utilization, and that the varying forms of organization have ramifications through to the characteristics of the people. Finally, this type of study brings the human geographer to grips with his logical starting point, what Zimmermann calls the dynamic resource population.[12]

[12] E. W. Zimmermann, "World Resources and Industry," Revised Edit., New York, 1951, p. 91.

THE PROBLEM OF POWER IN THE UNITED KINGDOM

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THE Suez crisis of 1956 has served to spotlight the difficulties being experienced by North West European countries in maintaining an adequate power supply to support expanding economies. Every significant industrial nation has built its industrial potential mainly upon indigenous power resources, and there is a distinct correlation between rise in national incomes and rise in power consumption. Thus where traditional power resources are unable to sustain industrial growth a serious problem arises. The problem is not purely a British one. In many industrialized countries conventional power resources are becoming overstrained or increasingly costly to utilize. Large imports of fuel become necessary, and this raises financial, political, and strategic difficulties. The global nature of the power problem has been clearly shown in the proceedings of a number of world power conferences, although the estimates made of future power requirements in the world as a whole vary widely. Recent papers suggest that the rate of increase of energy consumption for the world as a whole is such as to double the requirements every ten years.

Catering for increases as large as, or larger than, this presents grave problems in areas such as northwestern Europe where water power resources are approaching full exploitation or where the mining of coal brings difficulties of ever-growing complexity. In such areas oil is an essential supplementary fuel, but where requirements are entirely or mainly imported other difficulties arise. This is the background to the intensive work, especially in the United Kingdom, on the development of an alternative source of power to supplement traditional power resources, i.e., on the development of nuclear power. The importance of nuclear energy will vary from country to country. Where coal, oil, or water power is readily available the economic advantages of nuclear power are obviously less. Similarly, in poor or backward countries, the cost of atomic stations, plus the need for a high level of technological skill and other requirements that are by definition scarce, makes atomic power difficult to obtain. But for many countries (including the United Kingdom) and for certain areas within large countries with local power problems (e.g., New England) the stimulus to develop nuclear energy is very great. Even here nuclear power is not the sole answer to the energy problems of the future, and its contribution to the short-run problem will be comparatively small, though essential.

For the United Kingdom the problem of power is urgent. The country's industrial growth has been wholly, and still is mainly, based on coal resources. These resources are not now capable of exploitation to a sufficient degree to meet present and future energy requirements. To maintain a healthy econ-

TABLE I

UNITED KINGDOM ESTIMATED PRIMARY FUEL REQUIREMENTS, 1955–1980
SHOWING POSSIBLE SOURCES OF SUPPLY
(million tons coal equivalent)

Date	*Total requirements*	*Possible sources*			
		Coal	*Oil*	*Nuclear energy*	*Others*
1955 (actual)	250	214	35	0	1
1960 (est.)	280	230	48	0	2
1965 "	310	240	50	18	2
1970 "	340	240	57	40	3
1975 "	375	240	57	75	3
1980 "	410	240	56	110	4

omy, however, fuel consumption must continually increase. The rates of possible increase are subjects of debate, but Table I contains an estimate of what might be required in terms of millions of tons of coal equivalent. In 1955 the total primary fuel consumption in the United Kingdom reached 250 million tons of coal equivalent of which 214 million tons (86 per cent) came from coal, 35 million tons (14 per cent) from oil, and one million tons from "other sources," i.e., almost entirely from hydro-electric stations. The estimates made in Table I make allowance for a rise in living standards over the 25-year period. But even to maintain the economy at its present level in a competitive world will demand a steady increase in fuel consumption. The problem of power in the United Kingdom is the need to meet these inevitable requirements. An attempt is made in the remainder of this article to assess the possible contributions from the various sources open to industry in the United Kingdom.

COAL

The best opening comment in an appraisal of the coal industry's contribution is one taken from the introduction to the National Coal Board's Report for 1955:

> "Output in 1955 was disappointing. One major strike and many lesser disputes cost the industry more coal than in any year since nationalisation. Manpower fell. Home demand for coal was only met by means of massive imports and a reduction in coal exports. These measures seriously affected not only the Board's finances but the balance of payments position of the country."

The statistical position for 1955 may be usefully stated: deep-mines output, 210.2 million tons; opencast mines output, 11.4 million tons; total output, 221.6 million tons, i.e., about three million tons *less* than in 1954. Imports rose to 11.6 million tons, exports fell to 11.7 million tons. The general position of coal production relative to fuel consumption in recent years is shown in Figure 1. The graph shows that total inland fuel consumption has consistently exceeded total coal production. Under its Revised Plan for Coal (1955) the National Coal Board estimates that deep-mined coal production will reach about 230 million tons by 1965. Opencast mining will continue and is expected to produce 10 million tons per year up to 1965, declining thereafter. It is likely, therefore, that increasing deep-mined output after 1965 will do little more than offset the decline in opencast working, and the total pro-

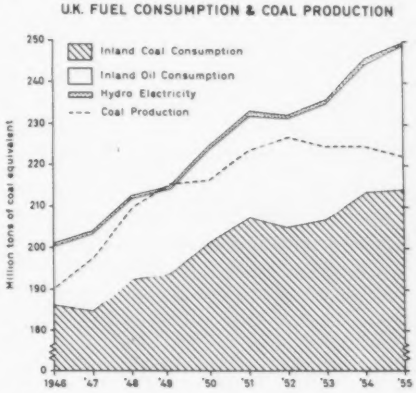

FIG. 1. (Sources: Ministry of Fuel and Power statistical digests.)

duced will probably remain at about 240 million tons, though the Coal Board optimistically hopes for an increase to 250 million. The lower figure is the more probable one and is used in Table I. This pessimism relating to the coal industry's capacity to increase its output substantially in the later 1960's is justifiable in view of the ever-increasing difficulties of production.

Extractive industries such as coal mining operate by consuming their own capacity to produce, and in many areas of the country coal resources have been long exploited. Though total reserves remain large, capacity to produce has been seriously curtailed and many pits have reached, or will soon reach, the limits of economic working. Over the next 15 years the Coal Board expects to close about 280 collieries now producing in aggregate some 30 million tons of coal per year. No reasonable input of capital could prolong the lives of these old collieries to any significant extent. This means on average a *loss* of two million tons of coal per year up to 1970, and capacity in other areas must increase by two million tons each year to maintain the *present* level of output. But meanwhile the productive capacity of mines with a longer life than 15 years at the present time will also be falling steadily. This too needs to be made good in order to maintain the existing level of output. Yet a further "factor of decline" is to be found in increasing output of less salable coal as poorer and dirtier seams are worked. The Coal Board estimates the total loss of capacity in these ways to be about four million tons *per year*. Thus in attempting to reach their new target of 230 million tons of deep-mined coal by 1965 (i.e., a 20 million ton increase on present output) the Coal Board must create new productive capacity of at least 60 million tons. Beyond that date merely to maintain output will require continued heavy investment in face of ever-increasing "factors of decline." With capital in short supply the question arises as to the possibility and desirability of allocating huge sums in perpetuity to the coal industry to maintain a certain level of output. Other fields for investment exist in which this capital may be better applied.

A further limiting factor to an increasing coal output lies in the difficulty of maintaining an adequate level of manpower. This is, at the present time, the crucial problem which high wages and steadily improving conditions have done little to solve. Output per manshift over-all is increasing in response to a high level of investment, though slowly (1.07 tons per manshift 1947, 1.22 tons per manshift in 1955). The need to produce every possible ton of coal causes highly uneconomic pits to be worked, for cost must be regarded as secondary to level of production. In 1955 six out of the nine National Coal Board Divisions produced coal at a loss varying from 1s-4d to 10s-9d per ton. Losses in individual areas reach much higher amounts, e.g., the Forest of Dean area was producing coal at a loss of £1-11s per ton in the first part of 1956. There is no immediate likelihood of coal requirements falling sufficiently to allow elimination of high cost mines. The output of Coal Board Divisions in 1955 is compared with that for 1938 in the map (Fig. 3).

There is no solution to the coal problem in the United Kingdom. Production is and will remain, insufficient throughout the foreseeable future. But there are palliatives. The crucial manpower problem could be eased, if not solved, by the acceptance at the collieries of foreign miners. Annual production would rise by several million

tons if labor relations could be improved, for strikes consistently cut output. Prevention of waste in use is another important palliative. Application of fuel efficiency measures could greatly ease the short-run situation, but fuel costs remain a relatively small item in the total costs of industry in general. Where capital is available to procure cost savings, it is usually regarded as better applied in other parts of the firm's installations and not in fuel saving appliances. Much waste could be prevented by charging an economic price for coal, i.e., a price to cover costs of production at highest cost pits, for this would make fuel saving a profitable business. This, however, is a very controversial issue. The more efficient utilization of some reserves could also be achieved by underground gasification and experiments are proceeding in Derbyshire. The gas produced so far has been of low thermal value (one-fifth of ordinary towns gas) and is thus uneconomic to pipe any considerable distance. It is therefore to be used on the site to generate electricity. This process can be used on thin seams too costly to mine, and also has the twin advantages of reducing manpower requirements and surface disturbance. Wider application depends on its further development, and on the price of electricity from conventional power stations, i.e., on the price of coal.

Naturally, increased supplies for the home market could be obtained by cutting exports still further. These already have to be balanced by imports, with consequent pressure on the balance of payments position. The total cost of imported coal in 1955 was about £2-8s per ton above the price at which it was sold on the home market. The Coal Board bears the loss, amounting to about £28 million in 1955. Exports are sold at the world price, which was

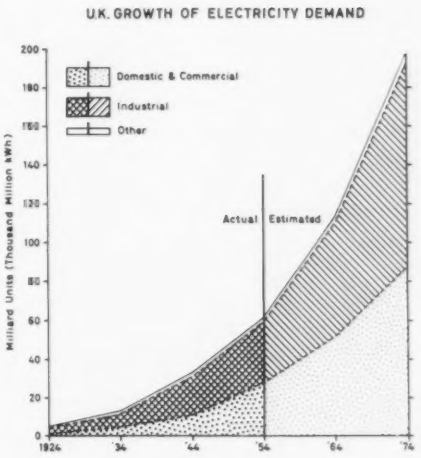

FIG. 2. (Sources: Actual figures from Central Electricity Authority reports and accounts; estimates culled from various sources.)

£1 per ton above the home market price in 1955 and the Coal Board made a £12 million profit on these. Financially, therefore, it is better for the Coal Board to cut exports than continue to import. But straightforward financial considerations are complicated by standing trading agreements, shipping interests, considerations relating to goodwill among trading partners, and so on.

With these background features in mind it is possible to estimate the part to be played by coal in future power requirements. Table I shows that coal may fall 170 million tons short relative to total fuel demand in 1980. But coal will remain the basic fuel of the economy until well beyond the 25-year period shown. By then, however, even if the economy has practically stagnated, coal will fall short some 60 to 70 million tons; if the growth of the economy is as rapid as some observers predict, the "fuel gap" may be more than 200 million tons.

Thus in 25 years' time coal is likely to provide something between 55 per cent and 80 per cent of the total fuel

supply, and a large gap must be filled by alternative power sources. The attempts of major coal burning industries in the United Kingdom to guard against possible serious coal shortages are important. The secondary power suppliers (the gas and electricity utilities) consume about one-third of all the coal consumed in the United Kingdom and may be used as brief examples.

For neither of these great utilities is the outlook for coal supply conducive to complacency. Both are expanding at rates which make fuel supply an urgent problem. The gas industry provides the most efficient form of coal

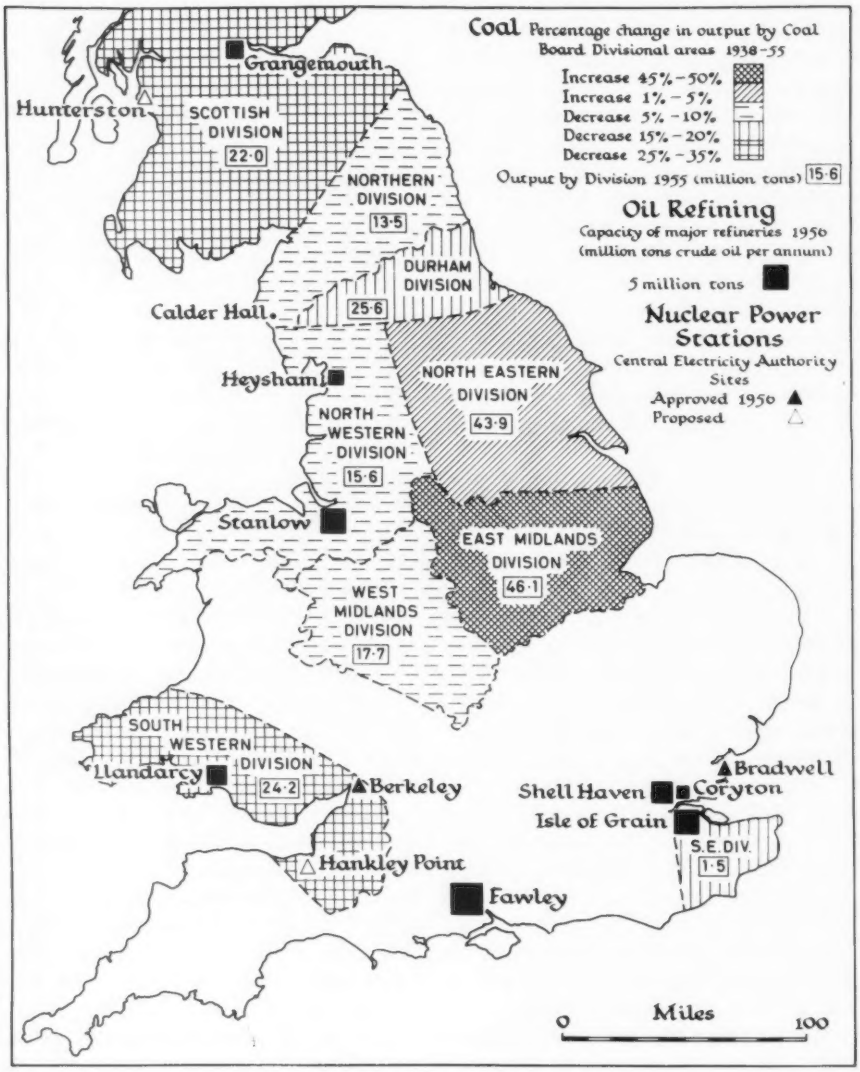

FIG. 3. United Kingdom power sources.

utilization (over 75 per cent thermal efficiency), and produces a variety of essential by-products. The high existing efficiency makes the scope for further improvement very small, but still higher efficiency ratios are being obtained by replacing old plant and developing techniques of coal blending, by the utilization of waste heat and so on.

These measures will not solve the problem of meeting future demand for towns gas, and alternatives are being sought. Thus, more gas is being purchased from coke ovens in iron and steel districts, the quantity reaching one-seventh of the total towns gas supply in 1955–56. The use of natural gas is another field for development. Small reserves are known to exist in the United Kingdom, e.g., near Dalkeith, and drilling programs are now in progress in Sussex and Yorkshire. Positive results would be very welcome, but the outlook does not seem very promising. Recently the question of imports of natural gas has come into prominence for, when frozen to −260° F., natural gas liquifies to one six-hundredth of its gaseous volume and bulk transport becomes possible. In this way large quantities of natural gas now being flared off at oil wells could become available to countries such as the United Kingdom. Questions of costs and economic feasibility are already being studied, but the project is one for the future; it cannot affect the immediate problem. A more immediate possibility lies in the use of methane drained from coal mines. This would aid coal production as well as give another source of gas, but would probably be of only local significance.

A final solution for the gas supply industry lies in the utilization of oil, or oil fractions for gas making. Plans are afoot to produce gas from heavy oil, and a plant is also being constructed to utilize oil fractions surplus to the requirements of oil refineries, e.g., alongside the Isle of Grain refinery. The utilization of refinery "tail gases" is also being examined, and agreements relating to their supply drawn up.

But such alternative sources of gas, based on the import of oil or natural gas, are not entirely satisfactory. It would put a large part of another industry at the mercy of import fluctuations, affect the balance of payments, and limit the supply of by-products. Preliminary steps to develop alternative sources of gas are being made in view of the possibility of a desperate coal shortage in the years ahead, but a transfer from coal to oil is not really desirable for the gas industry, which is, after all, the most efficient utilizer of suitable coals.

Power stations are the largest single coal consumers in the country (43 million tons in 1955). A doubling of electricity consumption every ten years since 1880 has meant a rapid increase in coal consumed, offset somewhat by increasing efficiency in power stations. There is no sign as yet of a slackening rate of growth, and much planned industrial expansion depends upon an increase, pari passu, of electrical power supplies (Fig. 2). It has been estimated that coal (or coal equivalent) requirements of the electricity supply industry will rise to 70 million tons by 1965, and probably to about 105 million tons by 1975. There is little possibility of sufficient coal being available to meet these requirements.

There are, however, other possible methods of increasing supply. The average efficiency of power stations was about 24½ per cent in 1956. New stations attain over 30 per cent efficiency and by replacing obsolescent plants coal can be saved. This requires a high and continuing level of investment, the gains from which must be

balanced against the advantages of alternative investments, e.g., in nuclear stations.

There are few other ways of increasing electricity output from indigenous sources. Hydro-electric and tidal barrage schemes, utilization of wind, heat pumps, and so on will be at best only marginal contributors—perhaps attaining an equivalent of four million tons of coal. Oil and nuclear energy must make up the gap, but each presents particular problems.

OIL

The difficulties associated with an increasing dependence on imported oil are economic, strategic, and technical. The long-term answer to the power problem must be in the use of atomic energy. But a broad gap exists now, and will continue in the immediate future, between energy demand and the coal industry's ability to supply. This shorter-term gap can be met only by imports of coal or oil, of which oil is the more economic.

Indigenous production of oil is negligible (53,000 tons from 223 wells in 1955) though the search continues. But oil refining has grown to the status of a major industry since 1945. Before the war the refining capacity of the United Kingdom was about two million tons per year, and consumption of petroleum products was about nine million tons per year. In 1955, refining capacity reached about 29 million tons, and consumption of petroleum products was 23¼ million tons (a coal equivalent of about 35 million). Eight major new oil refineries have been constructed, their location and capacity being shown on the map, and the United Kingdom is now a major oil refining country. These refineries have become an integral part of the industrial economy, affecting the chemical industry and many other users of oil derivatives, as well as achieving the "balance of power" between supply and demand for fuel. The dependence on the Middle East for crude oil supplies is well known, and the dangers to which a high level of dependence on imports of oil opens the economy have been clearly shown. The oil conversion program is to continue, the alternative being industrial stagnation, but quantities involved will be less than pre-Suez plans envisaged.

Industrial usage of the heavy oils (fuel, gas, and diesel oils) has risen by about 250 per cent since the war, and is expected to treble in the next five years. The steel industry, for example, is the largest single user, having developed oil firing in open-hearth furnaces and other uses since the war. The electricity authority has embarked upon a program of oil or dual-fired (i.e., oil or coal) power station construction, and may become a large oil consumer. In these and many other uses the consumption of oil will increase.

This raises technical problems relating to the balance of refinery output that can be only briefly commented upon here. The demand for the heavier products of the refineries is growing rapidly; that for the lighter fractions at a much slower rate. Between 1955 and 1965 demand for the gas, diesel, and fuel oil products is expected to rise by about 300 per cent, while the demand for gasoline and other petroleum spirit is expected to rise by 25 per cent. Already the refineries have difficulty in disposing of the lighter fractions and the unbalanced demand may affect the economics of refinery location in market areas such as the United Kingdom. Present expansion plans are noticeably lacking in catalytic cracking units. Table I contains estimates of the part to be played by oil in meeting future energy requirements. According to

some authorities these figures are conservative, and the 1975 total may be over 75 million tons coal equivalent. Table I shows that oil may at some stage supply about 20 per cent of total fuel requirements, but these estimates must be treated with reserve. Much will depend upon the rate of growth of nuclear generating capacity which has been in the habit of outdoing estimates. The peak years for oil demand will probably be in the 1970's, after which a small decline in oil requirements may be reasonably expected.

NUCLEAR ENERGY

All of the foregoing discussion leads up to the urgency of the need for nuclear energy in the United Kingdom. The first atomic power station to commence the public supply of electricity came "on stream" in October, 1956, at Calder Hall in Cumberland. At this time the government's tentative proposals for the development of nuclear energy, laid down in a White Paper in 1955, were already out of date. The generating capacity of nuclear stations based on the Calder Hall design will be more than double that of the prototype, while international events brought home the necessity for the maximum possible speed in the development of this new power source.

Under the provisional program for 1955–65 the United Kingdom government envisaged 12 nuclear power stations operating by 1965, providing 1500 to 2000 megawatts of generating capacity, i.e., equivalent to about five million tons of coal. The early advances on the prototype made these 12 stations capable of providing 3000 to 4000 megawatts, i.e., equivalent to about 10 million tons of coal.

The program will now be speeded up and a total of some 15 reactors of yet more advanced design will provide about 6000 megawatts of generating capacity by 1965, the equivalent of about 18 million tons of coal. New types of reactor, of higher efficiency, will be in the post-1965 program, e.g., liquid cooled as compared with the gas cooling of the present plant. These stations are to be built by private industrial companies for the Electricity Authority, which will own and operate them. The experience gained in the first few years of nuclear power station construction and operation should permit a faster rate of growth of nuclear generating capacity in the latter 1960's. It is possible that towards the end of the 1960's no new conventional power stations will be built at all, and all new generating capacity may well be in nuclear form. All of the nuclear capacity will be "base-load" capacity and by 1970 will be contributing a really significant amount to the country's fuel needs.

The availability of nuclear fuel (uranium) seems assured. Recent discoveries remove any danger of world shortage and, what is more, show that politically stable countries contain a large proportion of world reserves. These may be augmented by the development of thorium and of fast breeder reactors which produce more fuel than they consume. Cost considerations cannot be dealt with in detail here. Suffice it to say that it is generally thought that electricity will be produced at about 0.6 pence per unit, i.e., about the same price as from new coal-fired plant.

The question of location of nuclear stations is interesting. Sites now being developed or likely to be developed are indicated on the map. Calder Hall is owned by the Atomic Energy Authority, the research and training body which has establishments in various parts of the United Kingdom. Berkeley

(Gloucestershire) and Bradwell (Essex) are to be the first Electricity Authority Stations. Siting problems are unique. These stations are mainly required to serve the major centers of population in coal deficit areas at present served by coal fired stations, for which costs of coal transport are high. But popular misgivings relating to explosions and radio-activity play a part in actual location, although explosions are regarded as impossible and radio-activity is fully guarded against in construction. It is recognized, however, that the harmless nature of nuclear stations must be demonstrated for some years, and sites are accordingly being selected away from major population centers, though as near as possible to areas of heavy electricity demand. Unlike coal and oil fired stations, nuclear stations are virtually independent of fuel transport costs in their location, although the costs of distribution of current may be higher because of their location. The supply of cooling water is an important consideration. Nuclear stations rely on the old principle of raising steam heat to drive turbines, but they are of such great capacity as to require huge quantities of cooling water—about 20 million gallons per hour. Cooling towers would reduce this requirement, but quantities of "make-up" water remain very large. Thus a site by a large river or the sea is necessary, and at most sites the pumping installation required will entail heavy capital expense. Geological requirements are also more exacting than for conventional power stations, since reactors and their shielding impose unusually heavy loads. Finally, though not faced with problems of ash disposal, the disposal of radio-active waste imposes limitations on the location of nuclear generating capacity. Part of the waste must be permanently stored, but most will be discharged into the river or sea and this may affect other local interests.

The various new problems associated with the siting of nuclear power stations make the question of location rather difficult at the present time. As experience is gained and public confidence grows, however, several non-material factors now having to be considered in the location problem will diminish in importance, and it will be possible to locate the stations with greater regard for economic performance (especially with regard to distribution of the electricity). At the same time practical experience on the stations now being constructed will be leading to further improvements.

CONCLUSION

The problem of power in the United Kingdom, though complex and involving many variables in the shorter term, will eventually be solved by nuclear energy. The country has the greatest incentives to press on quickly with developments in this sphere, but present forecasts are liable to swift revision and the estimates of Table I must be treated with reserve. The atomic energy program may well, in the event, outdo the most optimistic forecast, but on the other hand difficulties of a financial and technical nature may slow progress down. It seems, however, that the United Kingdom is now firmly established on a course leading to the maximum possible development of nuclear power. It may well be that in pioneering in this field and in applying the prototype on a large scale to electricity generation, the country will eventually be placed at a disadvantage when compared with new constructions overseas, based on United Kingdom experience. This feature has its parallels in recent economic history. Heavy investment in early types of reactor may necessitate

postponement of the adoption of advanced types later, while future competitors in the field will be starting from the post-experimental stage. There are always risks in pioneering; but there are also opportunities, and the United Kingdom is not in a position to forego them. The very principles of atomic power application may prove to be primitive. The use of the heat produced by atomic fission to make steam to drive generators to make electricity may prove a wasteful form of utilization which a new and revolutionary technique could outmode. But the problem of power is an immediate one requiring immediate attention with all the facilities now at hand. To provide adequate power for the country's industries in 20 to 30 years' time requires planning and investment in nuclear energy now.

Atomic energy is, therefore, the long-term solution. In the short term the problem remains acute. In this the use of oil is essential, and must continue to underly much of the expansion of industry over the next 15 to 20 years. Even beyond that time it will remain an essential contributor. It is advisable to close by emphasizing the position coal will continue to hold. The table of estimated fuel requirements assumes that the whole of the output of coal is consumed within the United Kingdom. In fact the increasing fuel savings made by the generation of electricity in nuclear plant may permit the country to become a larger exporter of coal, whereas oil imports may be maintained at a fairly high level. Alternatively, coal output may be permitted to settle at a lower and more economic level. It is too early to make any forecast on this matter. Moreover, while coal in general will remain in short supply, small coals suited mainly to power station consumption will form a steadily increasing proportion of total coal output. The possibility of large surpluses of this type of coal is not to be discounted, and this may affect the future power program in both its oil and nuclear aspects. By any estimate, however, coal must remain the major fuel of the economy throughout the next 25 years. Beyond that time it will continue to be the solid, home-produced foundation for much of the country's industrial potential as a fuel and, increasingly, as a raw material. In the shorter term it is the vital prop on which the economy rests, and any increase in its contribution will help tremendously in solving the problem of power.

BOOK REVIEWS

Location and Space-Economy, by WALTER ISARD. xix and 350 pp.; diagrs., index. Published jointly by The Technology Press of Massachusetts Institute of Technology and John Wiley and Sons, Inc., New York, 1956. $8.75. 9 x 6 inches.

American students of economic theory have long been interested in the spatial aspects of economic development, but that interest has generally been somewhat casual and the product has appeared mainly in the form of short essays dealing with restricted aspects of these problems. For the general features of location theory Americans have generally found it necessary to rely on the writings of German economists, notably Weber, von Thünen, and Lösch. Since all of these general works are based primarily on the observation of conditions as they existed on the European continent in the pre-automobile era, and since these conditions differ considerably from those prevailing in present-day America, the current upsurge of interest in location theory among American economists is to be appreciated as well as welcomed.

In *Location and Space-Economy*, Walter Isard has assembled the most complete review of the literature that has yet been made available to American readers. His treatment of these various contributions is both accurate and critical, and the reader is left with not only a good understanding of current economic thought, but also of the major avenues along which future developments may be expected to appear.

To the average student of economic geography it appears that this volume may provide the best source of a much-needed comprehension of the forces and processes involved in the location of economic activities. Those locations, which the economist views as end-products of a variety of economic processes, provide the data, the areal descriptions with which the economic geographer typically begins his studies. Sooner or later the student of these areal arrangements must search for the *rationale*, the orderliness which is presumed to mark their arrangements in space. It is at this point that a knowledge of the operation of economic processes often becomes extremely helpful.

In particular, geographers seem likely to derive benefit from Isard's introductory chapter, in which he shows how areal differentiation might occur in the economic occupation of a hypothetical area. Chapter 3, which deals with "empirical regularities of the space-economy," presents an excellent review of some of the more important findings of social scientists who have directed primary attention toward the analysis of actual geographic situations. Students of trade areas and urban settlement will be especially interested in the graphic analyses presented in Chapter 11, some of which represent rudimentary space-models of the types often demanded by workers in these areas. The author promises further consideration of these and other types of regional arrangements in a forthcoming companion volume. We may hope that that promise is fulfilled.

The reader may well be cautioned in advance that it was not the author's purpose to provide an explanation of the locational features of any specific economic activity, or of the economic occupance of any specific area. Economic geographers will appreciate the author's restriction of content to the general topic of location theory—an enormous subject in itself.

H. H. MCCARTY

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The American Oasis, by EDWARD HIGBEE. xviii and 262 pp.; ills., bibliogr., index. Alfred A. Knopf, New York, 1957. $5.00. 8½ x 6 inches.

Many specialists have the commendable ambition to write a book that will inform and instruct the general reader. *The American Oasis* is such a book. It was not written for the specialist in geography or agriculture, but some of these colleagues will read the book with interest and profit.

The author of a popular book has many difficult decisions to make. Where does he start with background material, and how much should the background material be simplified and reveal itself in popular phrases and expressions? Geographers who write textbooks in beginning subjects in the field, or at any level, often face this same problem. Although the approach in *The American Oasis* is popular, the author does give us a quick and general inventory of American agriculture and some of his findings are

revealing and helpful. These preliminary observations seem proper because a book needs to be judged by its intent.

The author lists two main purposes in writing the book, namely, (1) "to clarify the regional differences in our farming and their related soil and water conservation problems," and (2) to describe the methods of our better agriculturists. This is attempted in ten chapters, of which the first three deal with man, climate, and land. Chapters 4 through 9 cover the major agricultural regions of the United States and lead to the last chapter, entitled "Forecast."

Parts of the book taste like good crisp lettuce just fetched from the garden. A considerable number of new (and old) agricultural practices and adjustments are described in the various sections of this country which the author visited recently on a 25,000-mile tour. This extended tour was made possible by financial support from the Conservation Foundation and the Old Dominion Foundation. Fairfield Osborn is credited with the general concept of the book. The author's major interest is reflected throughout in the theme of conservation. Although America is an oasis of plenty in the world, it is not a land reflecting uniformly good land-use practices. The running observations in the chapters reach back into history and also refer to examples of good, bad, and indifferent farming practices as they exist today. Perhaps it is understandable that the author frequently shifts from teaching to preaching.

This book is meant for relaxed reading. It has very few footnotes, one familiar map on erosion, and one short table. It leans heavily on impressions gained on the long tour as well as previous travel and work and on information gathered from interviews. Geographers will quickly pass to Part Two of the book, which deals with the major agricultural regions of this country.

Since the regional chapters cover this country from west to east, we are first introduced to dryland areas where practices and problems center on irrigation, range management, and forestry. Here, as elsewhere, the book dwells on farming practices rather than on immediate economic considerations. Technicians and even farmers usually know a great deal more about better practices than actually prevail. Money can change and improve a lot of things, but where do we find the money now to convert to what seems the ideal? To many the Federal treasury seems a promising source, but much of this money is already sluiced to western projects of dubious economic need or worth.

The Dry Plains (Chapter 6) pose a whole series of problems which may reflect a big gap between what is physically desirable and what is economically possible. Apparently, much land should be returned to grass, farm units should generally be larger, diversification with livestock is urged, much absentee ownership is questioned, and a dependable source of water is desirable. These objectives are hard to come by, although here and there trends may be encouraging. The author refers to the Oahe Dam in South Dakota as an example of what is needed to stabilize the Plains economy. Even if irrigation projects are developed in the Plains area, they can create only relatively small oases in this vast empire of country. Moreover, irrigation development costs are now nearly always many times greater than the value of the improved land. Do we need additional irrigated acres now or perhaps later?

The author urges wheat farmers to keep more cattle and detected a trend to graze more cattle. Total cattle population in counties may be impressive and may even show short-term or long-time increases. More cattle per county does not mean that more farmers are reporting them. In many counties the percentage of farmers reporting cattle has declined sharply. On many good wheat farms little or no grass remains to pasture cattle. While it is true that cattle can be kept with little or no pasture, the arrangement is not practical for some and does not appeal to others. Sidewalk farmers usually do not welcome this arrangement and these may represent up to nearly 40 per cent of the farmers in a county in the Winter Wheat Belt. Many wheat farmers prefer to diversify and stabilize their income with nonfarm jobs, particularly the sidewalk farmers.

The author pays tribute to the size and inherent soil qualities of the Corn Belt but censors the Corn Belt farmers for the little progress they have made in using approved land-use practices. A productive soil here has long endured destructive farming practices but deterioration is discernible in spite of high yields achieved with the use of commercial fertilizer. Changes to better land-use practices have come slowly because soil mining seemed to pay.

The Old Cotton Belt is covered in a chapter entitled "A New Frontier." Developments in this area excite the author, particularly in the Black Belt and portions of the coastal plains. The strong trend away from cotton is applauded and the marked increase in cattle population is approved. Erosion hazards are limited here, the growing season is long, and, with proper fertilization and rotation, particularly with grasses and legumes, these once poor and neglected areas are showing great promise. Much farm land can be and is being gained by drainage. Here is a flourishing agricultural empire in the making, parts of which may well compete with the Corn Belt in livestock enterprises based on corn, hay, and legumes. The tone and the promise here seem a bit on the optimistic side, particularly for the generality of farmers. What the big operator can do with plenty of capital is another matter.

Chapter 8, entitled "The Old Frontier," deals with the hill country in eastern United States,

which stretches from New England south and west to the Ozark area. Here subsistence is passing and the number of real farmers is declining. Nonfarm opportunities are spreading and are absorbing more and more of the small and marginal farm operators, many of them living on small acreages in the country. Expansion of grazing and hay crops on milder slopes is possible and is being promoted in some sections by larger operators. In southern New England the better lowlands are rapidly being urbanized and industrialized.

The American Oasis does a good job of reporting rather briefly on what is taking place in American agriculture. The general reader will learn some basic facts about this activity whereas the more professional reader gets glimpses of what is new and seems promising here and there. Other geographers will do well to emulate the author in addressing themselves to audiences larger than their own profession.

WALTER M. KOLLMORGEN

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Geographical Essays on British Tropical Lands, edited by R. W. STEEL and C. A. FISHER. (Contributors: R. J. HARRISON CHURCH, B. H. FARMER, C. A. FISHER, V. C. R. FORD, A. T. GROVE, D. B. MATHER, E. PAGET, and R. W. STEEL.) x and 344 pp.; maps, diagrs., tables. George Philip and Son, Ltd., 1956. 35s. 8¾ x 5½ inches.

The three cohesive elements of this book are revealed in its title: the essays are geographic, they were written by Britishers about British territories, and the territories are all tropical. Aside from these common features, there is no central theme nor uniformity in approach. On the contrary, the essays well illustrate the varied contributions that geographers can make to the study of numerous tropical problems. Two of the studies are primarily concerned with the analysis of physical conditions (A. T. Grove: Soil Erosion in Nigeria; B. H. Farmer: Rainfall and Water-supply in the Dry Zone of Ceylon); two essays are devoted to transport and trade (V. C. R. Ford: The Trade of Lake Victoria and Its Marginal Lands; R. J. Harrison Church: The Transport Pattern of British West Africa); three studies deal largely with demographic conditions (E. Paget: Land Use and Settlement in Jamaica; D. B. Mather: Migration in the Sudan; R. W. Steel: Some Problems of Population in British West Africa), and one two-part essay is an example of the historical and political geographic approach (C. A. Fisher: The Problem of Malayan Unity in its Geographical Setting). As Steel points out in an introductory chapter, however, there is in each of the essays, irrespective of the approach or the branch of geography represented, a common concern with the relations of man and land.

The quality of the eight essays is of a high order. They are not only informative regarding their subjects and areas, but are valuable as examples of the geographic approach. The 48 illustrations include many excellent maps which are not readily available elsewhere. It may be noted, however, that much of the content of several of the essays has appeared in other publications. This is the case of the contributions of Grove, Farmer, Ford, Harrison Church, and Steel. Delays in collection and publication have also slightly reduced the value of a number of the papers, though Steel's claim that their continued validity indicates the significance of the underlying geographic realities, is justified.

The essay by Steel on British West African population problems begins with an excellent summary of the population distribution of this area and of the character of available maps. Among the problems briefly discussed are the pressure of tremendous densities in specific areas, the declining food production in some areas where food demand is rising, and the peculiar difficulties occasioned by mining and urban agglomerations. He notes the need for long-term land-use planning, the urgent necessity for improved methods of farming, and the requirements for more intensive demographic research, considered critical in some areas.

Harrison Church's writing on West African transport patterns illustrates the fundamental significance of rail lines, roads, and ports to economic development. It contains much interesting historical material which at once shows the weight of geographic factors in constructing and maintaining routeways and the unfortunate wastes resulting from failure to adopt the most rational approaches.

Grove's essay, "Soil Erosion in Nigeria," is more than the name implies, for it first presents a brief and well-illustrated summary of the geography of Nigeria, a summary which reveals a constant awareness of the two-way impact of man and his environment. This is followed by studies of soil erosion in three closely settled areas: Onitsha and Owerri Provinces, the most thickly populated part of Nigeria where some of the most spectacular gullies in the world are to be seen; the Jos Plateau; and Katsina Province.

Mather's contribution discusses the nature and impact of the migration of westerners into the former Anglo-Egyptian Sudan. He estimates that about a quarter of a million have accumulated in the central and eastern sections of the grassland region, and that about 10,000 to 20,000 are moving into the area each year. Westerners pick from 20 to 30 per cent of the cotton in the Gezira and occupy 23 per cent of the holdings in the Gash Delta.

In "The Trade of Lake Victoria and Its Marginal Lands," Ford concludes that there is very little sign that the lake has been a unifying

influence, that it has rather acted as a dividing sea. Inter-regional trade within the basin has thus far been meager and there has been little development of a common culture among the lacustrine peoples. The overwhelming importance of Kisumu among lake ports is clearly developed.

Paget admirably succeeds in "Land Use and Settlement in Jamaica" in combining two approaches: "the general, which treats the island as a unit of production, a cypher in the wider pattern of empire," and "the detailed, which finds ample grist in one sugar mill."

Farmer's analysis of the "Rainfall and Water-supply in the Dry Zone of Ceylon" is the most detailed physical analysis in the volume. The importance of his presentation is evident from the increasing efforts being made to colonize the area, comprising nearly three-quarters of the island. He concludes that, despite considerable opportunities, the shadow of over-population will loom in Ceylon as it already looms in India if present demographic trends continue.

Fisher, in "The Problem of Malayan Unity in Its Geographical Setting," considers the reasons for the seeming paradox of the physical unity and political disunity of the peninsula. He concludes that many of the political decisions made over the years and particularly in the last decade have unintentionally acted to maintain or fortify the disunifying cultural aspects.

WILLIAM A. HANCE

Columbia University

USA: Die Erschliessung eines Kontinentes, by HANS BOESCH. 272 pp.; maps, ills. Kümmerly & Frey, Bern, 1956. 19.05 sfr. 8½ x 6 inches.

This book is written for the general reader and should be judged in light of this purpose, not as text book or reference book. In the reviewer's opinion, it fulfills its purpose admirably. Moreover, it is not a "popularized" book but one full of thought and substance. As such, it should prove of value to anyone teaching a course on North America. To students preparing for general and language examinations it should be doubly useful. It provides a relatively brief general review of North American geography and gives practice in fairly simple German dealing with familiar subject matter. It seems possible that a translation would find an American market, though intelligent editing for the American reader would be essential in some portions of the text.

The dominating theme of the book is, speaking generally, the evolution of the cultural landscape, but Boesch goes beyond the visible landscape. He has an historical bent, but the book cannot be called historical geography. Cultural forces are given much attention. Naturally, in a book of this length and type, the selection of material must be highly subjective. Professional readers may not like all the author's choices but they will almost certainly agree that he has chosen with perspective and sense of balance.

There are of course minor errors, some arising from over-condensation. For instance, not all the streams of the northern Rockies drain into the Columbia (p. 193). Other seeming errors may be more nearly differences of opinion. The reviewer doubts that the narrowness of Appalachian valleys had much to do with the preservation of Pennsylvania Dutch (German) speech and customs (p. 56).

The illustrations and maps are adequate for a book of this type, though here, even more than in the text, the choice of materials can be debated. Some of the color photographs appear to be incorrectly exposed. Figure 13, in particular, does not do justice to the Grand Canyon. Nevertheless, the use of color for nine of the illustrations certainly is an attractive feature. The typography is excellent. It speaks well for the publishers and their public that such a substantial book about the United States can be published.

STEPHEN B. JONES

Yale University

Industrial Location in the New York Area, by JOHN I. GRIFFIN. xiii and 212 pp.; charts, ills., index, bibliogr. Monograph 1 of New York Area Research Council, The City College Press, New York, 1956. $5.00. 9 x 6 inches.

This monograph by Professor Griffin is one of several studies resulting from a grant by the Rockefeller Foundation for the purpose of developing materials and graduate courses on the New York Metropolitan Area as a focus of American urban civilization. Resulting from such a concept, this study will be of interest to students of urban culture, and the particular subject will be of interest to those dealing in the economics of urban areas and in industrial development.

A fourfold purpose is stated for the study: to interpret present industrial patterns; to identify all the larger firms in the New York Area; to present the results of a questionnaire and interview program intended to reveal attitudes toward locational factors; and to consider some issues of public policy raised by the evidence on attitudes and out-migration of industry.

The area chosen for the study comprises 15 counties: Bronx, Kings, New York, Queens, Richmond, Nassau, Rockland, Suffolk, and Westchester in New York State; Bergen, Essex, Hudson, Middlesex, Passaic, and Union in New Jersey. The study is limited to the man-

ufacturing industries because of their "particular significance in the employment-creating process."

The background data presented for the area are drawn from the employment security programs of the two states involved. These statistics are tabulated by major industry groups, Standard Industrial Classification, for each county generally covering the period from 1947 to 1954. The total number of manufacturing establishments and the number of establishments employing 100 or more persons are also tabulated for each of the counties.

From questionnaires sent to executives of a sample of establishments employing 100 or more persons, a rating was developed for such locational factors as factory buildings, room for expansion, rent, and access to markets. The factors were scored with a plus 50 for the most favorable, plus 40 for the second most favorable, and so on. The unfavorable factors were scored with a minus 50 for the most unfavorable, minus 40 for the second most unfavorable, etc. No respondent scored more than ten factors. The algebraic sum of the ranks for each factor was then divided by the number of respondents ranking that factor and the mean score calculated for each factor by county. Tabulations are given for the rank and mean score for each factor by county.

A concise history of the industrial development of Passaic County and the case history of the relocation of the American Safety Razor Corporation from Brooklyn sketch additional facets of the changes in the industrial patterns of the area. The study of the relocation case is based primarily on statements by representatives of the company, labor unions, and public officials as well as on some of the specific economic factors involved in the shift of the company.

The monograph touches briefly on the problem of out-migration of manufacturing from the central city and the region, and illustrates one method of gathering information on this poorly documented change which is common to many metropolitan areas. Professor Griffin makes a plea for more recognition, on the part of public officials, of the importance of the manufacturing industries, and for a more factual and objective approach by the public agencies offering information and aid to firms seeking new locations.

Included in appendices are: a listing by name of the firms of the area employing 100 or more persons by major industry group and location; statements on the American Safety Razor Corporation case; and a bibliographical essay on theoretical and applied economic studies of industrial location.

The primary contribution of the monograph is the compilation of data on the New York Area, and a suggestion of sources and uses of data on changes in firm locations. The general objective of the research project and the specific objectives stated for the monograph are adequately met.

Although the study is concerned with changes in patterns both in space and time, only the changes in time are adequately illustrated. This reader found tabulations by county insufficient to provide summary statements of spatial shifts; distribution maps would have been helpful. A less important oversight is the lack of identifying numbers on the trend charts.

GRADY O. TUCKER, JR.

Boston, Mass.

Europäer in Ostafrika, by ERNST WEIGT. xiv and 385 pp.; maps (including ten folded maps in end pocket), ills., bibliogr. Selbstverlag des Geographischen Instituts der Universität Köln, 1955. DM 12.50. 9½ x 6¾ inches.

A general idea of the scope of this book can be obtained from the titles of the chapters. These are in sequence: Area and Climate, Tropical Climate and Man, Population, Labor, the Economy of the Europeans, Land Use, and, in the second part, the Individual Area of Settlement, covering Tanganyika, Ruanda-Urundi, Eastern Belgian Congo, Uganda, and Kenya.

Less than 100,000 whites, chiefly European, live in this tropical area, most of them in the uplands where temperature conditions are more favorable. A study of white men in the Tropics is always welcome and this is especially the case for East Africa where the future of white settlement in Negro Africa is at stake. On the credit side—in judging this book—it can be said that the author did a good, industrious job, based on personal acquaintance with parts of the area and on a careful study of what has been written by others. His bibliography contains more than 300 references most of them in German and not well known to us here in the United States. Of special value are his evaluation of white settlement from a health point of view (his verdict is rather favorable), his discussion on soils and land use, and his discussion of land properties.

On the debit side the study is too encyclopaedic: too many details. It is a book that is nice to have around for information but is not inspired reading. Some of the material is rather old. Who cares for instance whether a certain plantation in 1939 had 20 pigs? Some of the maps in the text are poorly drawn.

But on the whole the study is a valuable contribution to our knowledge of East Africa and should be read by anyone who plans to go there or settle. It treats all factors fairly (some of them are liabilities) and still comes to an encouraging conclusion.

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